PUBLIC WORKS

City, County and State

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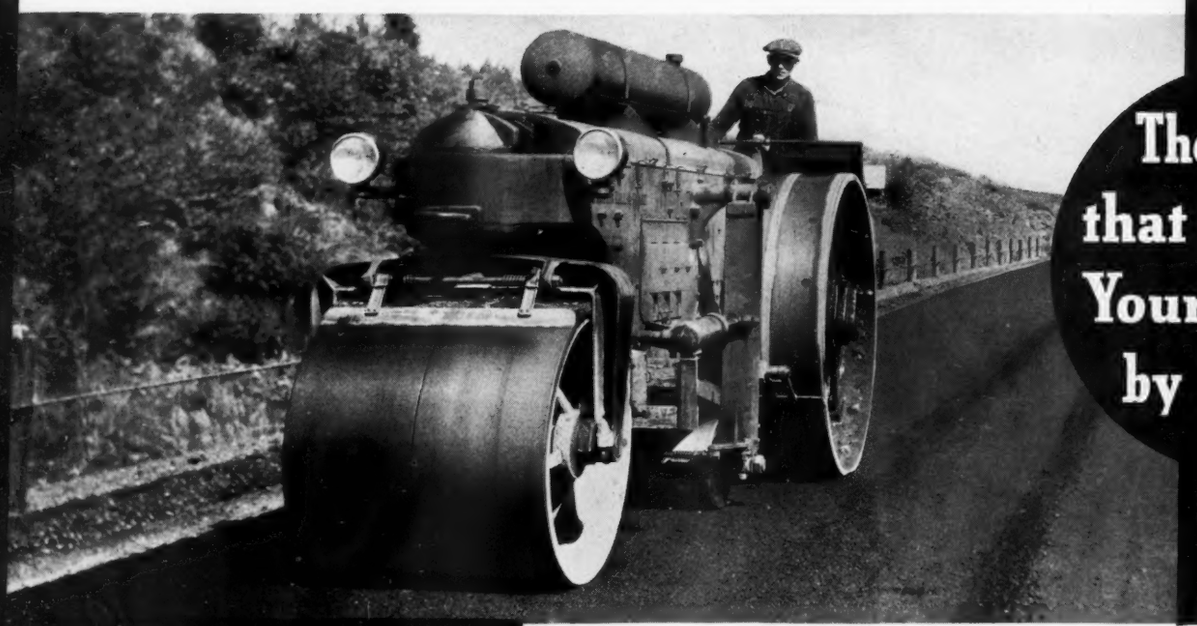
San Francisco-Oakland Bridge, now nearing completion, is expected to be open to motor traffic by November

In This Issue

Indexes of Highway Construction Costs
Ditch Treatment for Beautification
The Municipality's Problem of Human Wastes
Installing and Lining Water Mains in Tucson

JULY, 1936

Roll-A-Plan



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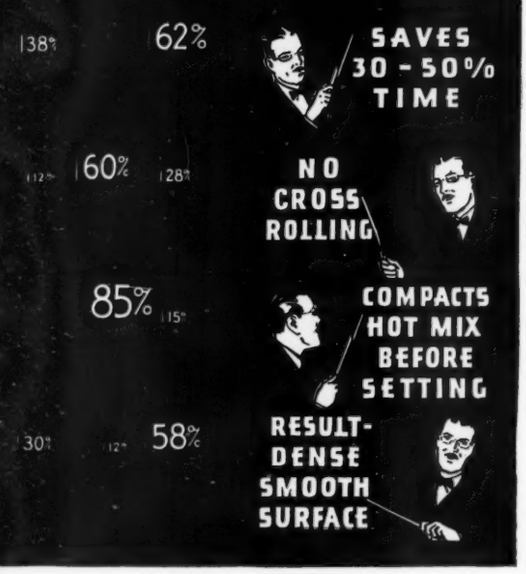

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City, County and State Engineering and Construction

JULY, 1936

VOL. 67, NO. 7

Contents

EDITORIAL 19

HIGHWAYS AND AIRPORTS:

Indexes of Highway Construction Costs 11
Beautifying a Cliff in San Francisco. *By C. W. Geiger* 15
Draining a Mississippi Underpass 16
A Michigan Grade Crossing Elimination 20
Studies of Highway Lighting 26
Salvaging Curb and Gutter with a Mudjack. *By Harry L. Stevens* 26
Lighting Construction Work to Reduce Hazards of Night Driving 26
Gasoline Taxes Yield $619,000,000 in 1935 31
Knoxville's New Airport 40
Transplanting Roadside Trees in California 42

SEWERAGE AND DRAINAGE:

Ditch Treatment for Sanitation and Beautification. *By A. H. Fletcher* .. 9
The Municipality's Problem of Human Waste. *By G. H. Hazlehurst* ... 14
Replacing Failed Sewer in Rochester. *By Elmer Van Gelder* 18
Treating Creamery Wastes on Trickling Filters 23
Distillery Wastes 24
The DIGESTION TANK 36
A Year's Sludge Incineration at Dearborn 42

WATER SUPPLY AND PURIFICATION:

Installing and Lining Water Mains in Tucson, Ariz. *By Phil J. Martin, Jr.* 17
Painting Steel Water Tanks 21
Iron and Manganese Removal by Catalytic Reagents. *By W. G. Kirchoffer* 30
The WATER WHEEL 33
The American Water Works Association Convention 45

DEPARTMENTS:

New Equipment 52
Readers' Service Department 55
The Engineers' Library 58

TIMEWASTERS

Arkansas Cut-ups:

Take a sheet of paper in the shape of a cross, with all sides equal. Cut this cross with two straight snips of the scissors, in such a way that the pieces formed will make a perfect square when put together. *H. B. Carruth, Nashville, Ark.* (NB: These cute red crosses that the Red Cross is putting out make fine experimental material, and we suggest a sort of handicap game, to wit: Contribute a 25c piece to the Red Cross for every one of these you cut up in trying Mr. Carruth's problem. Ed.)

"So Here's Another"

That is the kind of letter we like to get, because it surely wastes our time to keep enough of these things on hand. Well, anyway, here is a right good one from John H. Anderson, of Michigan. "What are the three dimensions of a box of the least cubical contents to hold two balls, one of 3-inch diameter and the other of 1-inch diameter? Mr. Anderson gives an answer that just doesn't look quite right to yours truly, and we hope that some kind hearted mathematical experts will have uniform and correct answers ready for us by the time we get back from our little tour of army duty which runs from July 5 to 18.

Solutions:

Answers to last month's problems may take some more space than usual; here are some of them:

Several correct answers on the bullseye problem. The marksman, expert or sharpshooter who does better than 100 in six shots, making four 17's and two 16's, will get honorary membership in the Order of the Boar, which meets this very month at Carlisle, Pa.

Those numbers mentioned last month are a peculiar proposition, and we do not know how they can be solved. If there is a mathematical solution we'd like to have it sent on. Mr. Carruth sent in the only answer to this one, as follows:

$$8169 \times 3 = 24{,}507;\ 9168 \times 3 = 27{,}504;$$
$$6819 \times 3 = 20{,}457;\ 5694 \times 3 = 17{,}082.$$

We didn't know about the last mentioned number, our fourth one being 6918, which also does the trick. There must be five of these numbers, therefore.

Mr. Carruth also states that Mr. Blunk's rock, mentioned in the June issue, drops 495 feet. Mr. Blunk violated Commandment No. 1 of this organization, which has for its purpose helping out the editor. He did not send the answer along with the problem. Is it right, Mr. B? W. A. H.

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A. PRESCOTT FOLWELL, Editor **W. A. HARDENBERGH,** Asso. Editor

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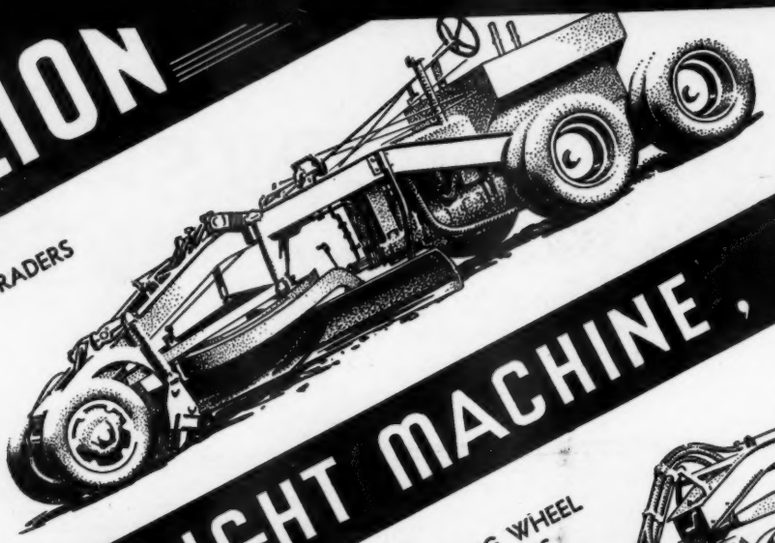
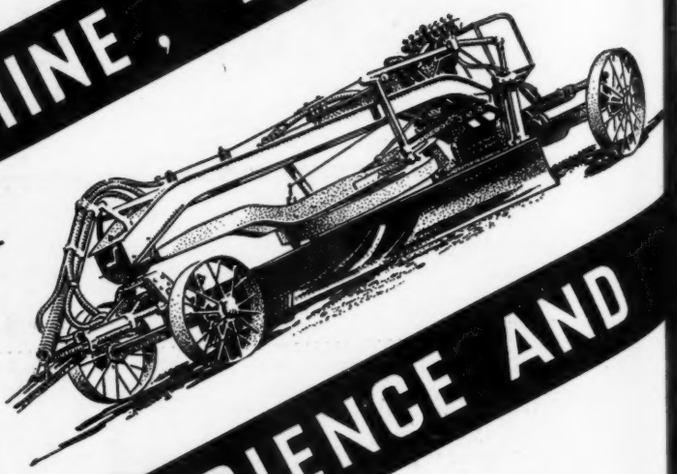
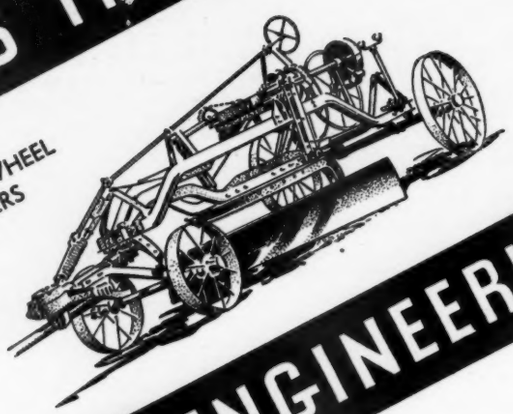


MOTOR GRADERS

HAS THE RIGHT MACHINE, BACKED BY

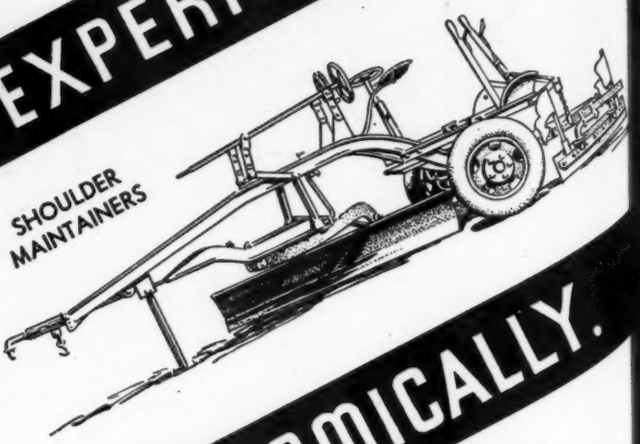


LEANING WHEEL GRADERS

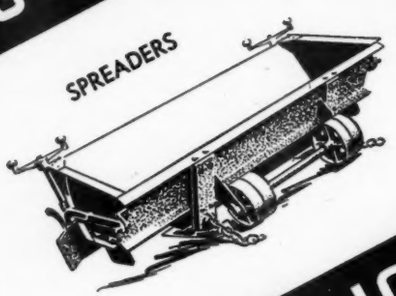


STRAIGHT WHEEL GRADERS

SOUND ENGINEERING EXPERIENCE AND



SHOULDER MAINTAINERS



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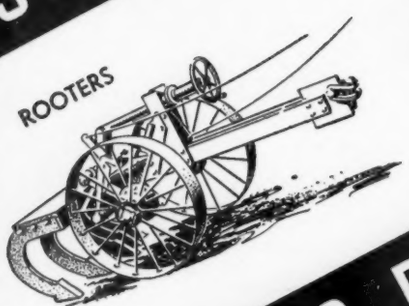
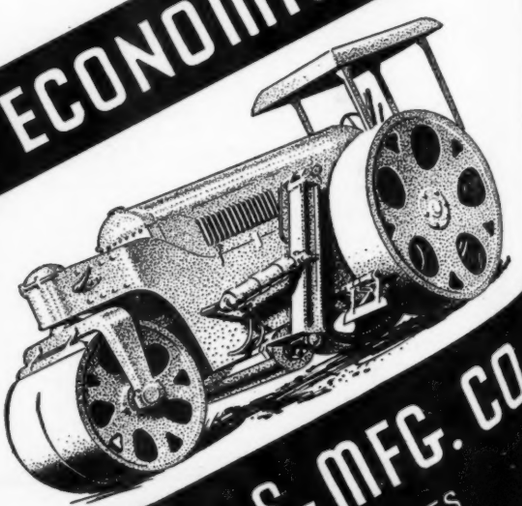


ROOTERS



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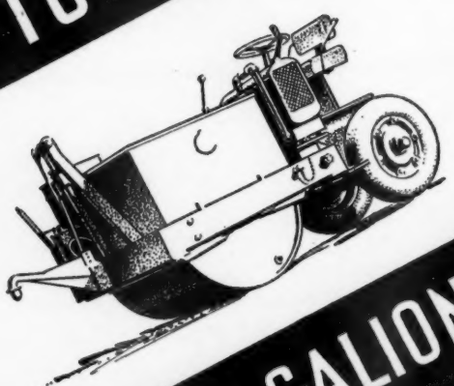

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Vol. 67 *July, 1936* No. 7

Figs 1 and 2. A ditch in Overton Park, Memphis, before and after treatment

Ditch Treatment for Beautification

By ALFRED H. FLETCHER
Sanitary Engineer, Memphis, Tenn.

ONE type of relief project that has proven generally popular in Memphis after two and one-half years of this work is the stabilizing of ditches by straightening, sloping banks, concreting, rip-rapping of bottoms, sides and walls, and sodding of sides or banks. The original purpose of the ditching work was to provide for adequate drainage during heavy rains, to eliminate erosion and damage, and to cut down on the day after day and week after week of oiling for malaria-mosquito control work. One important by-product—the results in beautification—has rallied strong public approval to this type of project.

Ugly looking, eroded and even dangerous ditches have been transformed into places of beauty. In most cases the better the job of flood and mosquito control, the greater the transformation from the standpoint of beauty. Another point that might be stressed is that this type of work is reducing future maintenance costs to the city, while many other types of new construction work will call for increased operation and maintenance cost.

Pictures shown indicate the different designs that may be used to suit the conditions met. In Fig. 1 is shown a badly eroded ditch with pot holes holding water at the culvert outlet, and the threat of undermining trees and even of narrowing the roadway by encroachment. Fig. 2 illustrates the use of rip-rap bottom and wall on a one-quarter to one slope with considerable filling behind the walls with smaller waste stone, broken concrete, bricks and dirt. The design for the wall in this case must be such as to stand even though some settlement takes place in the fill behind the wall.

In constructing a complete rip-rap lining of walls and bottom, the walls are installed first. It is important in getting a uniform alignment to use slope stakes for the top and bottom and slope of the wall, usually 1 horizontal to 4 vertical, or steeper. The wall must be carefully constructed, and a solid foundation or footing is of first importance. The wall is begun a foot or more, if necessary, below the grade of the ditch to reach a solid foundation. The pieces of rip-rap are placed with the flat side up, not parallel to the bottom of the ditch, but perpendicular to the slope of the bank, the straightest edge is placed out as a part of the wall surface. The wall joints are usually filled by slapping and brushing a one-to-four mix of cement mortar into them, especially at sections of ditch where the velocity or scouring is severe. Weep holes are left about every twenty-five feet to allow water entrapped behind the wall, especially in fills, to seep out into the ditch.

The bottom is built up or cut to a grade so that the flat face of the rip-rap when placed will meet the final grade line of the ditch lining. If the bottom can be lined when dry, care should be taken to have the dirt bottom firm and well tamped when fill is necessary. If the bottom is lined when the ditch is carrying a flow

Fig. 3, top center, concrete lining, flat side slopes; Fig. 4, left, treatment at intersections; Fig. 5, right, concrete center and rip-rap sides.

of water, rip-rap should be used to fill holes and a gravelly or coarse material should be used for fill with the voids filled with dirt. As the rip-rap is laid on the bottom, each piece is placed carefully just as in building a wall, and tamped with the dirt bottom scraped away or added to make the flat piece of rip-rap lay flat and firm and to grade. A man on the bank slides pieces of rip-rap down to a man in the ditch who passes each piece to the rip-rap layer as he needs it. A half dozen or more crews may be placing rip-rap at the same time.

After all of the rip-rap has been placed, a finish man with a helper goes the entire length of the section, tamping and testing each piece to be sure all are firmly placed and to grade. On a wide bottom, a straight edge is used from the center line grade to the side of bottom grade to insure a uniform bottom with a substantial slope to the center line for dry weather flow and no low or high places to cause water to stand.

There is a distinct advantage in using a concrete center lining as shown in Fig. 5 to carry the dry weather flow as this prevents or minimizes the deposition of gravel and dirt and formation of dams and pools of water.

In general, the cost of the concrete lining has run about ten cents per square foot for material including the cement, sand and gravel, while in the rip-rap work the only material purchased is cement and sand for grouting. The broken concrete used for rip-rap has been obtained free for the breaking out and hauling, and this has run about one cent per square foot. All sod used has been free. Because of the use of relief labor, no attempt has been made to show unit costs of excavation or laying concrete, rip-rap or sod. A total of over ten miles of ditches have been stabilized to date.

Sod can be used on the dirt bank above and over the top of the wall and extend from the inner edge of the ditch walls to several inches over the top of the bank. It is important to tamp and settle the dirt-fill behind the wall to prevent later settling and breaking of the wall in places. If broken stone is used for fill, the voids should be filled with dirt and tamped as the fill is made and then covered with a blanket of sod.

In Fig. 5 a treatment is shown for a ditch running the length of a parkway in the center of a beautiful park drive with lanes of traffic on both sides of the park. The ditch was crooked and had eroded wide. The rustic effect of the completed ditch which seems to fit the location and surroundings. A wide top was possible using a narrow bottom and flatter slopes about one to one. The top of the slope was sodded. The center lining is concrete with a short radius to provide a narrow channel to minimize the formation of pools during the dry weather flow.

A ditch through a beautiful subdivision (Chickasaw Gardens) scoured during heavy rains. Pot holes holding water and eroded banks detracted from the dignity of the beautiful neighborhood. Fig. 3 shows the use of a center lining of concrete with a short radius, with additional width of bottom using rip-rap and then a flat two to one, or flatter, lining of rip-rap laid entirely with the flat face of the broken concrete. Extra care was taken to use a good grade of filling material and to tamp thoroughly to prevent later settling and consequent breaking of rip-rap lined bottom and sides.

Fig. 4 shows an "after" view of the intersections of two small ditches at a street. There previously had been no bridge existing at this point and which aggravated the scouring action in requiring a right angle turn, as one of the ditches flows head-on into the road embankment.

These types of ditch stabilization are recommended for work relief projects, not only for flood and malaria control, but as a beautifying move. The work in Memphis has proven very popular, judging by the comments of citizens, public officials, public health authorities and local newspapers.

The author wishes to acknowledge the efficient work of W. M. Welborn, Superintendent of Construction for the Malaria-Mosquito Control Division of the Department of Health, who deserves credit for carrying out these lining projects.

Acknowledgment is also made of the photographs which were taken and developed by Marvin F. Carter, Technical Assistant, Bureau of Sanitation of the Department of Health.

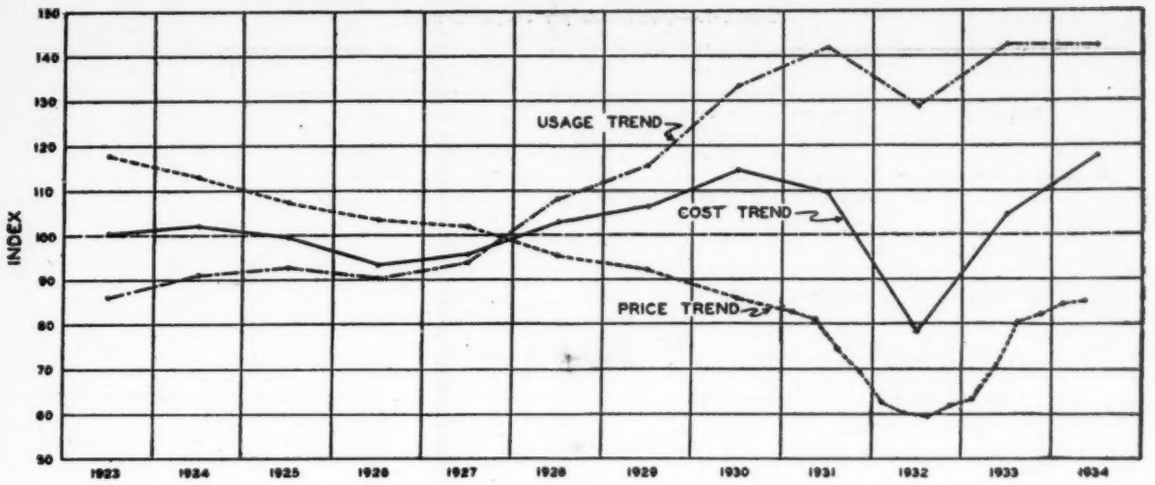


Fig. 2. Variations in price, cost and usage trends

Indexes of Highway Construction Costs

A Report by the Division of Management, Bureau of Public Roads, as Published in Public Roads

THE purchasing power of funds expended for highway construction, when expressed in miles of highway annually placed under construction, shows variations from year to year because of (1) actual variations in the cost of materials and labor entering into such construction, and (2) changes in design features, types, and quantities of materials actually used.

The effect of lowered prices of constituent units is immediately reflected in a downward trend in costs per mile whenever the quantities of materials used and labor required are subject to only minor variations. However, changing traffic conditions have required wider surfaces, longer sight distances, flatter curves, and other features conducive to safety with increased speed. Consequently the effects of lower unit prices during recent years have been largely offset by the increased quantities of materials and excavation actually used, and average costs per mile have not fluctuated in accordance with fluctuations in the unit price of materials.

As a normal consequence of constantly increasing traffic, highway construction is continually undergoing changes, both in design and in materials used, and these changes have tended to complicate the development of simple index figures. To meet this condition three sets of index figures have been prepared.

1. A price trend index, based on the varying unit costs of a composite mile composed of the same quantities and materials for each year.
2. A usage trend index that shows the variations in quantities of excavation, surfacing, and structures actually placed in the composite mile constructed each year.
3. A cost trend index, that is based on the actual cost of the composite mile constructed each year.

Data for the Federal fiscal years 1925 to 1929 were taken as a basis for the calculations. The variations in price trend for the years 1922 to 1935 for the major components as well as for the composite mile are shown in figure 1.

Price, cost, and usage trend indexes are shown in figure 2 for the period 1923 to 1934. The effects of price and usage are combined to produce a cost trend for the composite mile. The cost trend follows a more uniform course than does either the usage or the price trend.

Cost Trend for Composite Mile of Highway

The data covering materials, quantities, and unit costs were collected by the Bureau of Public Roads from the prices shown in the contracts awarded for road construction financed in whole or in part from Federal funds allotted to the States for construction on the

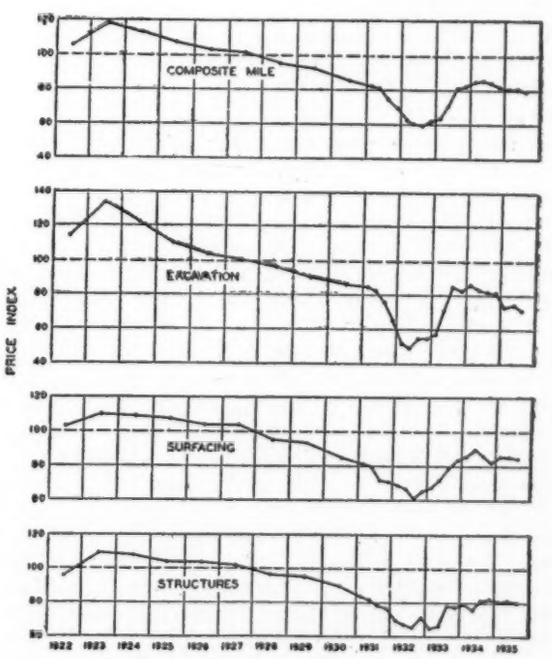


Fig. 1. Variations in price trends of major components and of composite mile.

TABLE 1.—*Quantities per surfaced mile*

Year	Excavation				Surfacing					Structures		
	Excavation	Gravel [1]	Waterbound macadam [2]	Total excavation	Bituminous macadam	Bituminous concrete [3]	Brick [4]	Portland-cement concrete	Total surfacing	Reinforcing steel	Structural steel	Structural concrete
	Cubic yards	*Cubic yards*	*Cubic yards*	*Cubic yards*	*Square yards*	*Square yards*	*Square yards*	*Square yards*	*Square yards*	*Pounds*	*Pounds*	*Cubic yards*
1923	8,068	3,846	1,002	12,916	453	307	227	2,764	3,751	9,270	2,297	53
1924	8,364	3,792	1,237	13,393	391	351	137	2,960	3,839	12,374	2,258	67
1925	9,238	4,116	945	14,299	385	284	120	2,978	3,767	13,581	4,718	64
1926	11,068	4,695	837	16,600	405	215	103	2,452	3,175	14,070	3,629	68
1927	10,960	4,310	1,329	16,599	400	237	53	2,850	3,540	12,773	3,301	64
1928	12,545	4,050	757	17,352	692	273	86	3,297	4,348	17,075	4,953	65
1929	17,028	4,548	1,029	22,605	350	213	62	3,173	3,798	22,503	5,024	81
1930	18,946	4,426	797	24,169	345	247	92	3,640	4,324	26,852	7,750	122
1931	22,361	4,801	683	27,845	423	214	75	2,282	3,995	30,751	12,216	141
1932	18,423	4,874	692	23,989	429	218	76	3,332	4,055	29,243	10,807	102
1933	21,461	5,017	908	27,386	561	492	81	2,609	3,743	32,131	19,249	153
1934	28,270	6,163	684	35,117	515	508	42	1,360	2,425	29,963	21,733	158

[1] Includes sand-clay and topsoil.
[2] Includes treated and untreated macadam.
[3] Includes sheet asphalt.
[4] Includes all block pavements.

Federal-aid highway system. Samples were taken from work financed wholly with State funds and it was found that Federal-aid and State projects were built to about the same standard.

Careful consideration of the available data led to the conclusion that a satisfactory usage index could be obtained if a composite mile of surfacing representative of the types of construction in Federal-aid and State annual programs were used. Accordingly, the component types of surfacing entering into the composite mile were taken from records of the combined highway mileage built annually, and the correlated items (grading, structural concrete, and steel) were based on the records available from construction with Federal funds. The propriety of the above procedure is assured by the fact that governing specifications are the same for both Federal-aid and wholly State construction, and that design and supervision of construction are performed by the State highway departments.

From Bureau of Public Roads records of bid prices:

Excavation—Common; unclassified; rock.

Structures—Reinforcing steel; structural steel; structural concrete, class A; structural concrete, class B; structural concrete, class C.

From records of mileage of State highways constructed: Gravel and sand-clay; macadam; bituminous macadam; bituminous concrete; portland-cement concrete; brick.

These items cover somewhat more than 90 percent of the total cost of highway construction. Therefore though their number is not great, they appear to be adequate. The items not used involve about the same basic commodities, manufacturing processes, transportation problems, and the same classes of labor that were involved in the items used. To include them would complicate the calculations but probably would neither clarify nor improve the result.

These representative items were accumulated and weighted, and further consolidated into three general groups—excavation, surfacing, and structures. The general group of excavation includes the three types of excavation, common, rock, and unclassified, and in addition includes the low-type surfaces such as topsoil, sand-clay, gravel, and treated and untreated macadam. These low-type surfaces have a low materials cost. generate little freight, and in construction methods and nature of equipment used are similar to grading operations, and so may be readily converted into the general group of excavation. In a similar manner the rigid types of surfacing have been converted into equivalent concrete pavement. Structures, which include bridges, culverts, railroad grade crossings, and safety devices, were reduced to three items: Reinforcing steel, structural steel, and structural concrete. The resulting final quantities per surfaced mile are shown in table 1.

Base quantities and base prices (1925 to 1929) are shown in table 2. The base quantities and prices are the arithmetical averages of the quantities and prices by years for the base period.

The price index.—The method of computing the price index is shown in table 3. The composite mile on which the price index is based is composed of the average quantities of excavation, surfacing, and structures as determined for the base period 1925 to 1929. The average bid price for each of these items is shown for the years 1922 to 1935. The figures given in the amount columns are the costs of the average quantities at the prevailing rate for the year or quarter. The index figures give a comparison between the year or quarter and the base period 1925 to 1929. The results given in this table are shown in graphical form in figure 1.

The usage index.—The usage index shows the effect of changing practices in design features and use of materials in the highway-construction field. It is obtained by applying the average prices as determined for the base period to the various quantities of the base items used. The result shows how the cost would have varied because of changing usage had the unit prices remained constant. These changes in construction practices are shown in tabular form in table 4, and graphically by the usage trend in figure 2.

The cost index.—The cost index is obtained by combining the average annual quantities used, as shown in table 4, with the average annual unit prices that they cost. This index is shown in tabular form in table 5 and graphically by the cost trend in figure 2.

TABLE 2.—*Base quantities and prices*

Year	Excavation		Surfacing		Reinforcing steel		Structural steel		Structural concrete	
	Quantity	Price per cubic yard	Quantity	Price per square yard	Quantity	Price per pound	Quantity	Price per pound	Quantity	Price per cubic yard
	Cu. yd.		*Sq. yd.*		*Lb.*		*Lb.*		*Cu. yd.*	
1925	14,299	$0.386	3,767	$2.360	13,581	$0.0565	4,718	$0.0667	64	$22.534
1926	16,600	.364	3,175	2.286	14,070	.0534	3,629	.0736	68	22.760
1927	16,599	.282	3,540	2.291	12,773	.0510	3,301	.0707	64	22.647
1928	17,352	.337	4,348	2.096	17,075	.0492	4,953	.0671	65	21.216
1929	22,605	.316	3,798	2.055	22,503	.0481	5,024	.0591	81	21.582
Total	87,455	1.755	18,628	11.088	80,002	.2582	21,625	.3372	342	110.739
Average	17,491	.351	3,726	2.218	16,000	.0516	4,325	.0674	68	22.148

TABLE 3.—*Price trend in highway construction*

Year	Excavation [1] (17,491 cubic yards)			Surfacing [2] (3,726 square yards)			Structures								Composite mile	
							Reinforcing steel (16,000 pounds)		Structural steel (4,325 pounds)		Structural concrete (68 cubic yards)		Combined			
	Bid price [3]	Amount	Sub-index	Bid price [3]	Amount	Sub-index	Bid price [3]	Amount	Bid price [3]	Amount	Bid price [3]	Amount	Amount	Sub-index	Total amount	Index
Base period, 1925 to 1929	$0.35	$6,139	100.0	$2.22	$8,264	100.0	$0.052	$826	$0.067	$291	$22.15	$1,506	$2,623	100.0	$17,026	100.0
1922	.40	7,031	114.5	2.26	8,488	102.7	.050	809	.074	321	20.18	1,372	2,493	95.1	18,012	105.8
1923	.47	8,186	133.3	2.43	9,047	109.5	.057	920	.078	338	23.37	1,589	2,847	108.6	20,080	117.9
1924	.43	7,504	122.2	2.40	8,950	108.3	.057	920	.077	333	22.91	1,558	2,811	107.2	19,265	113.1
1925	.39	6,751	110.0	2.36	8,793	106.4	.056	904	.067	288	22.53	1,532	2,724	103.9	18,208	107.3
1926	.36	6,367	103.7	2.29	8,518	103.1	.053	854	.074	318	22.76	1,548	2,720	103.7	17,605	103.4
1927	.35	6,157	100.3	2.29	8,536	103.3	.051	816	.071	306	22.65	1,540	2,662	101.5	17,358	101.9
1928	.34	5,894	96.0	2.10	7,810	94.5	.049	787	.067	290	21.22	1,443	2,520	96.1	16,224	95.3
1929	.32	5,527	90.0	2.05	7,657	92.7	.048	770	.059	256	21.58	1,468	2,494	95.0	15,678	92.1
1930	.30	5,300	86.3	1.86	6,949	84.1	.045	715	.061	264	20.08	1,365	2,344	89.4	14,593	85.7
1931																
First quarter	.30	5,195	84.6	1.79	6,666	80.7	.042	672	.055	240	18.90	1,285	2,197	83.7	14,058	82.6
Second quarter	.29	5,072	82.6	1.77	6,580	79.6	.041	658	.051	219	18.48	1,257	2,134	81.3	13,786	81.0
Third quarter	.27	4,705	76.6	1.59	5,924	71.7	.040	634	.052	224	17.49	1,189	2,047	78.0	12,676	74.4
Fourth quarter	.23	3,988	65.0	1.56	5,809	70.3	.037	594	.056	244	17.22	1,171	2,009	76.6	11,806	69.3
1932																
First quarter	.18	3,166	51.6	1.52	5,656	68.4	.036	571	.049	211	15.22	1,035	1,817	69.3	10,639	62.5
Second quarter	.17	2,991	48.7	1.47	5,481	66.3	.034	538	.045	197	14.98	1,019	1,754	66.8	10,226	60.1
Third quarter	.19	3,358	54.7	1.35	5,045	61.0	.033	526	.043	184	14.82	1,008	1,718	65.5	10,121	59.4
Fourth quarter	.19	3,323	54.1	1.44	5,377	65.1	.033	528	.048	208	16.28	1,107	1,843	70.3	10,543	61.9
1933																
First quarter	.20	3,498	57.0	1.49	5,552	67.2	.032	506	.043	187	15.44	1,050	1,743	66.4	10,793	63.4
Second quarter	.25	4,338	70.7	1.58	5,894	71.3	.035	552	.043	188	14.67	997	1,737	66.2	11,909	70.3
Third quarter	.30	5,194	84.6	1.74	6,498	78.6	.041	657	.049	212	17.36	1,180	2,049	78.1	13,741	80.7
Fourth quarter	.29	5,054	82.3	1.85	6,904	83.5	.042	669	.049	212	17.12	1,163	2,044	77.9	14,002	82.2
1934																
First quarter	.30	5,247	85.5	1.90	7,079	85.7	.042	672	.049	212	17.82	1,212	2,096	79.9	14,422	84.7
Second quarter	.29	5,072	82.6	1.98	7,377	89.3	.042	678	.051	221	17.31	1,177	2,076	79.1	14,525	85.3
Third quarter	.29	5,016	81.7	1.92	7,161	86.7	.042	680	.053	231	17.98	1,222	2,133	81.3	14,310	84.0
Fourth quarter	.29	4,988	81.3	1.82	6,781	82.1	.044	712	.057	245	17.81	1,211	2,168	82.7	13,937	81.9

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.
[3] Indexes and totals were calculated with the bid prices carried to 1 more decimal place than that to which they are shown in this table.

TABLE 4.—*Usage trend in highway construction*

Year	Excavation [1] ($0.351 per cubic yard)			Surfacing [2] ($2.218 per square yard)			Structures								Composite mile	
							Reinforcing steel ($0.0516 per pound)		Structural steel ($0.0674 per pound)		Structural concrete ($22.148 per cubic yard)		Combined			
	Quantity	Amount	Sub-index	Quantity	Amount	Sub-index	Quantity	Amount	Quantity	Amount	Quantity	Amount	Amount	Sub-index	Total amount	Index
	Cubic yards			*Square yards*			*Pounds*		*Pounds*		*Cubic yards*					
Base period, 1925 to 1929	17,491	$6,139	100.0	3,726	$8,264	100.0	16,000	$826	4,325	$291	68	$1,506	$2,623	100.0	$17,026	100.0
1923	12,916	4,533	73.8	3,751	8,320	100.7	9,270	478	2,297	155	53	1,174	1,807	68.9	14,660	86.1
1924	13,393	4,701	76.6	3,839	8,515	103.0	12,374	638	2,258	152	67	1,484	2,274	86.7	15,490	91.0
1925	14,299	5,019	81.7	3,767	8,355	101.1	13,581	701	4,718	318	64	1,417	2,438	92.9	15,810	92.9
1926	16,600	5,827	94.9	3,175	7,042	85.2	14,070	726	3,629	245	68	1,506	2,477	94.4	15,346	90.1
1927	16,599	5,826	94.9	3,540	7,852	95.0	12,773	659	3,301	222	64	1,417	2,298	87.6	15,976	93.8
1928	17,352	6,091	99.2	4,348	9,644	116.7	17,075	881	4,953	334	65	1,440	2,655	101.2	16,990	108.0
1929	22,605	7,934	129.2	3,798	8,424	101.9	22,503	1,161	5,024	339	81	1,794	3,294	125.6	19,652	115.4
1930	24,169	8,483	138.2	4,324	9,591	116.0	26,852	1,386	7,750	522	122	2,702	4,610	175.7	22,684	133.2
1931	27,845	9,774	159.2	3,995	8,861	107.2	30,751	1,587	12,216	823	141	3,123	5,533	210.9	24,168	141.9
1932	23,989	8,420	137.2	4,055	8,994	108.8	29,243	1,509	10,807	728	102	2,259	4,496	171.4	21,910	128.7
1933	27,388	9,612	156.6	3,743	8,302	100.5	32,131	1,658	19,249	1,297	153	3,389	6,344	241.9	24,258	142.5
1934	35,117	12,326	200.8	2,425	5,379	65.1	29,963	1,546	21,733	1,465	158	3,499	6,510	248.2	24,215	142.2

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.

TABLE 5.—*Cost trend in highway construction*

Year	Excavation [1]				Surfacing [2]				Structures										Composite mile	
									Reinforcing steel			Structural steel			Structural concrete			Combined		
	Bid price [3]	Quantity	Amount	Subindex	Bid price [3]	Quantity	Amount	Subindex	Bid price [3]	Quantity	Amount	Bid price [3]	Quantity	Amount	Bid price [3]	Quantity	Amount	Amount	Subindex	Amount	Index
		Cubic yards				*Square yards*				*Pounds*			*Pounds*			*Cubic yards*					
Base period, 1925 to 1929	$0.35	17,491	$6,139	100.0	$2.22	3,726	$8,264	100.0	$0.052	16,000	$826	$0.067	4,325	$291	$22.15	68	$1,506	$2,623	100.0	$17,026	100.0
1923	.47	12,916	6,045	98.5	2.43	3,751	9,107	110.2	.057	9,270	533	.078	2,297	180	23.37	53	1,239	1,952	74.4	17,104	100.5
1924	.43	13,393	5,746	93.6	2.40	3,839	9,221	111.6	.057	12,374	711	.077	2,258	174	22.91	67	1,535	2,420	92.3	17,387	102.1
1925	.39	14,299	5,519	89.9	2.36	3,767	8,890	107.6	.056	13,581	767	.067	4,718	315	22.53	64	1,442	2,524	96.2	16,933	99.5
1926	.36	16,600	6,042	98.4	2.29	3,175	7,258	87.8	.053	14,070	751	.074	3,629	267	22.76	68	1,548	2,566	97.8	15,866	93.2
1927	.35	16,599	5,843	95.2	2.29	3,540	8,110	98.1	.051	12,773	651	.071	3,301	233	22.65	64	1,449	2,333	89.0	16,286	95.7
1928	.34	17,352	5,848	95.2	2.10	4,348	9,113	110.3	.049	17,075	840	.067	4,953	332	21.22	65	1,379	2,551	97.3	17,512	102.9
1929	.32	22,605	7,143	116.4	2.05	3,798	7,805	94.4	.048	22,503	1,082	.059	5,024	297	21.58	81	1,748	3,127	119.2	18,075	106.2
1930	.30	24,169	7,323	119.3	1.86	4,324	8,064	97.6	.045	26,852	1,200	.061	7,750	473	20.08	122	2,449	4,122	157.2	19,509	114.6
1931	.27	27,845	7,546	122.9	1.68	3,995	6,696	81.0	.040	30,751	1,227	.054	12,216	655	18.02	141	2,541	4,423	168.6	18,665	109.6
1932	.18	23,989	4,378	71.3	1.44	4,055	5,859	70.9	.034	29,243	994	.046	10,807	499	15.32	102	1,563	3,056	116.5	13,293	78.1
1933	.26	27,386	7,066	115.1	1.67	3,743	6,240	75.5	.037	32,131	1,195	.046	19,249	889	16.15	153	2,470	4,554	173.6	17,860	104.9
1934	.29	35,117	10,184	165.9	1.91	2,425	4,622	55.9	.043	29,963	1,285	.052	21,733	1,139	17.73	158	2,801	5,225	199.2	20,031	117.6

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.
[3] Indexes and totals were calculated with the bid prices carried to 1 more decimal place than that to which they are shown in this table.

The Municipality's Problem of Human Wastes

By GEORGE H. HAZLEHURST
Chief Engr. & Dir., Bureau of Sanitation, Alabama Dep't. of Public Health

THE factors of economics loom large in the life and prosperity of a municipality, just as they do in the life and prosperity of the human being. Inseparable from the life of each, if real happiness and progress are to be had, is health—both individual and community. The bedrock upon which community health rests is environmental sanitation and the keystone of the health structure must incorporate safe and efficient methods for the disposal of human wastes. Centuries before our scientific knowledge told us why, mankind learned from experience how disastrous to human life gross neglect of this factor always proved to be. Consequently, the first concern of every municipality should be the economic and public health aspects of providing sound ways for protecting its entire population against the dangers arising from this source.

Municipal water-carried feces disposal is accomplished by the installation of a sewer system. In this effort the municipality acts as a corporate unit. It provides for the plan, the construction, the financing and the use of the system. These powers are delegated to it by legislative fiat. They are the powers of organization, taxation and police. Financing may be upon the basis of abutting property values, or property value, plus the use of funds derived from general taxation (and justified upon the basis of general public health value) or upon the basis of service received by the individual. In any case, the municipality, acting as a corporation, uses its collective credit in lieu of credit of the individuals forming it. Payments by the individuals to the municipality are divided into relatively long term obligations, secured by real property, or collected as utility rates.

Economics will determine largely what areas of the municipality can be served through such a sewer system. This is simply a statement of what group of the population it can afford to serve by this method. By deducting this group from the whole population there is left another group not provided for in its municipal plans. This latter group is, however, part of the municipality. It, too, has like feces disposal problems. It, too, has its acute economic problems. Neither can its public health problems be divorced from the whole. The municipality has acknowledged by the restricted area covered by its water-carried system, that it is not economically feasible or possible to serve this other group with such a system; hence, the feces disposal problem for this particular municipality is, by no means, either properly or adequately solved.

It would then seem that the logical procedure would be to seek another kind of a system to serve this other group. Such a system must function without water carriage and it must not be as expensive, nor must it be any more expensive in proportion.

This other system may take the form of ground burial in a protected pit. Its cost is much less than that of the water-carried system. The same method of planning installation and principle of financing is due this system as was used in installing the water-carried system, if justice is to be done to all citizens and the municipality does not shirk its responsibility to this group as well as the first group.

The problem of feces disposal for the lower economic group can not be adequately or justly solved by the municipality delegating one of its powers—the police power—to the health department. Police power alone is inadequate, for the problem of financing is as real in the installation of a pit toilet system as it is in the installation of a water-carried system. It is manifestly a discrimination to provide time or split payments for one group of citizens and refuse this privilege to another group. It is equally evident that it is in principle as illogical to expect the health department to build and maintain a system of feces disposal for the lower income group, with nothing but the police power, as it would be to expect it to build the water-carried system with this power alone.

Actually, many municipalities have grossly shirked their responsibility to the individuals and the population by attempting to shift to the health departments the construction and maintenance of the feces disposal systems serving the lower income groups. That the policy would not succeed could have been predicted by any one with rudimentary knowledge of municipal purpose and power. That the health departments have carried the burden of millions of dollars of construction and maintenance is at once a credit and a discredit.

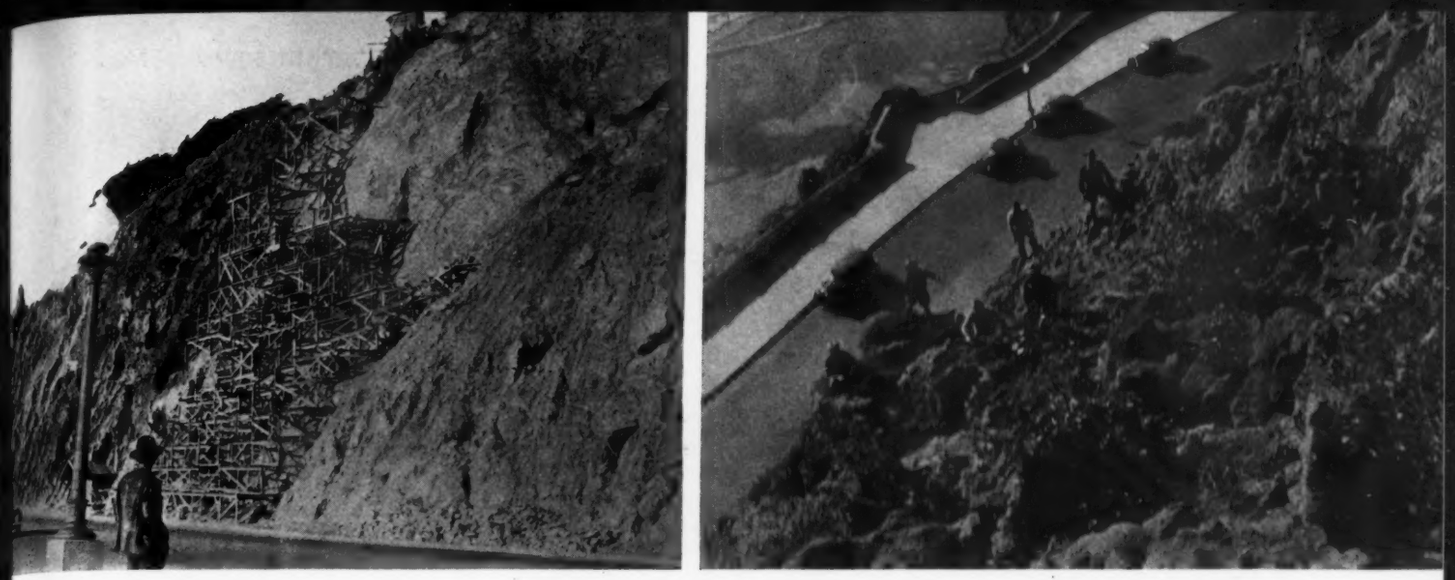
As municipal life is lived, these two groups, so clearly cut in two, for purpose of discussion, do not really exist. Areas merge into each other. Water supply pipes may precede sewer pipes, and in other instances sewer pipes may run ahead of certain property economics.

An intermediate system presents itself for consideration—part water-carried, part burial. The form taken is a septic tank with ground absorption field. It is likewise a part of the whole problem and should be so regarded.

The municipality is a heterogeneous aggregation viewed from many points. In these interlapping zones many conditions are found where economics demand adjustments, yet the feces disposal problem must be cared for. If property is classified and methods of disposal are likewise classified adjustments can be made to meet conditions, physical and economic.

The classes of property may conceivably be a private dwelling, two-family dwelling, or a multiple dwelling. By dividing the latter into two main groups, A and B, four classes result, which for normal municipal conditions seem adequate. Any one of these classifications may be found in different physical and economic conditions where feces disposal would consist of sewer connections, septic tank installations or sanitary pit toilets; the adequacy of service, of course, being specified. The use of water under pressure, rather than availability of such service, is a primary economic and physical cleavage plane, which makes unnecessary financial investigation through banker, doctor, minister or priest.

That municipalities have been willing to attempt to shift responsibility is unfortunate. That their engineering staffs have been willing to do a piecemeal job of municipal sanitation is likewise unfortunate. If public health is to be adequately safeguarded, and public decency preserved, the present situation in many municipalities needs an overhauling and a change.



The illustration at the left shows the work under way, with a portion of the completed cliff as it appears from below, while at the right is shown a close-up view of the work and workmen looking down from above.

Beautifying a Cliff in San Francisco

By C. W. GEIGER

FOR many years the rock from the 200-foot high cliff overlooking the Cliff House and Cliff House Drive in San Francisco, has been slipping and falling down onto the highway. In an effort to stop this, work has been carried on by the Park Commission, which when completed will prevent any more rock from sliding down onto the highway.

The surface of the cliff is being covered with cement and rock to a depth of from 4 to 6 feet, which not only acts as a prop in helping to hold the rock in place, but entirely shuts out the air, fog and water, the elements which cause the rock to disintegrate, become loose and fall. The surface of this cement and rock covering is painted a volcanic color and trees, shrubs and flowers are planted over the entire surface of the cliff in order to beautify it. A special system of perforated water pipes has been installed over the surface of the cement and rock covering, but in such a manner as to be inconspicuous while supplying water to the shrubbery.

In special pockets built into the surface, rich earth is placed, and in this cypress and olive trees, lilies and numerous other flowers and shrubs are planted.

The work has been carried on by an elaborate system of scaffolding extending from the highway to the top of the cliff, a height of about 200 feet. On this scaffolding which extends almost straight up, the men work, loosening and removing the unsound rock from the face of the cliff. They then apply the cement and new rock, which are carried down from the top of the cliff in chutes.

In the accompanying illustrations, the one below shows a section of the cliff before the face covering work began. That at the left above is taken from about the same position after the work was well under way. The illustration above and at the right is taken looking down from the top of the cliff showing the workmen and some of the shrubs, trees, and flowers that have been placed.

This shows the appearance of the cliff before work was begun. Methods of work are described in the accompanying article.

At Laurel, U. S. 11 passes under two mainline railroads

Draining Two Mississippi Underpasses

THE Mississippi State Highway Department is cooperating with the United States Bureau of Public Roads in the commendable program of eliminating dangerous railroad grade crossings on main highways in the state. Such grade eliminations involve construction of either underpasses or overpasses, depending upon the topography of each crossing location.

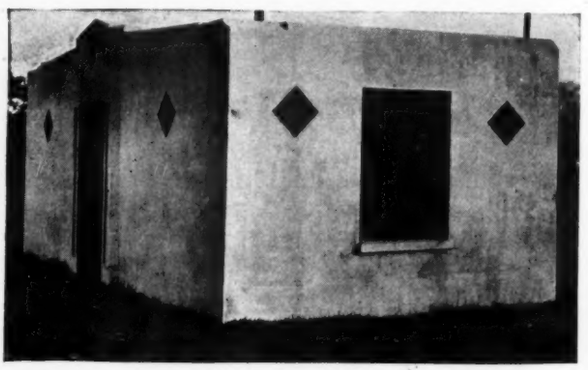
An underpass usually requires provision for artificial drainage of storm water, as is the case with both of the projects already completed at Laurel and Leland, Miss. For pumping out storm water, two identical installations, including pump buildings and pumping equipment, have been constructed at these two underpasses. Each installation consists of the following equipment: two Fairbanks-Morse vertical, submerged-type, column-suspended trash pumps, each having a capacity of 1500 g.p.m. against a total dynamic head of 22 ft., driven by two F-M 15-hp. vertical, ball-bearing, hollow-shaft electric motors, and one F-M multi-cylinder gasoline engine.

Operation of the motors and pumps is automatically controlled by switches that function with the rise and fall of water in the pump pit. One or both pumps will operate automatically depending upon the pumping necessary to take care of the inflow of water.

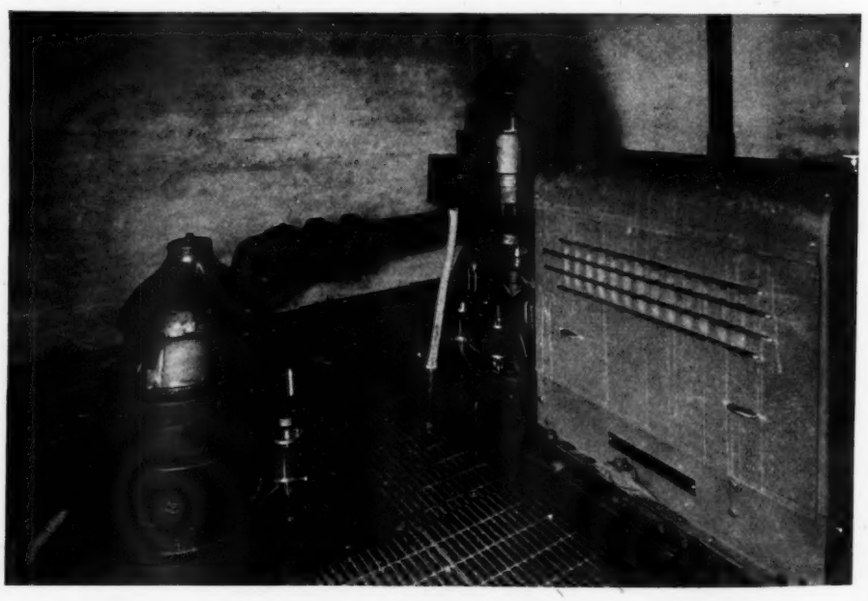
A feature of these installations is the standby gasoline engine power provided for one of the pump units at each station, which operates only in case of the failure of electric power. This emergency engine drives the pump through a Johnson right-angle gear and free-wheeling type Falk-Rawson flexible coupling.

In the event of electric power failure, the gasoline engine is automatically brought into service through a series of relays which start the engine, like the motors are started, when water reaches a certain level in the pump pit. When electric service is again available, the motors automatically replace the engine in driving the pumps.

The underpass at Laurel is on U. S. Highway 11 under two main-line railroads, the Southern Railway System and the Gulf, Mobile & Northern Railroad. The one at Leland is on U. S. Highway 82 under the main line of the Illinois Central Railroad. The underpass at Laurel is rather long because the two railroad lines under which the highway passes are located about a hundred yards apart.



This attractive building houses the pumping equipment at the Leland, Miss., underpass.



In the event electrical power fails, the gasoline engine drives one of the pumps.

Installing and Lining Water Mains by Relief Forces in Tucson

By PHIL J. MARTIN, JR.
Superintendent, Tucson Water Department

THE Tucson Water Department proposed and submitted to the relief organization during the fall of 1934 a project calling for the replacement of 3,900 feet of 6-inch cast iron pipe with 1,300 feet of 12-inch and 2,600 feet of 10-inch cast iron pipe. It was also proposed to relay 2,100 feet of the 6-inch pipe in another location.

The project was set up for the E. R. A. to furnish all common labor, the city to furnish all materials, supervision and transportation. The Government's share of cost was to be $23,100 and the city's share $12,510 making the total cost of the project $35,610.

The water department had all pipe on hand but had to purchase valves, fittings and joint compound at a cost of approximately $3,500.

The project was designed to accomplish two things: First to enlarge certain water mains in a low-pressure district, and second to obtain water pipe for a street that was to be paved and which required water mains to be installed prior to paving.

Phil J. Martin, Jr.

It was desired to use 6-inch pipe on this street. The water department had no 6-inch pipe on hand but did have the 10 and 12-inch pipe. It was considered economical to exchange the 6-inch pipe in a district that needed larger pipe, for the 10 and 12-inch pipe in stock.

The work was started in September and finished in January, at a total cost of $36,712.57, which was $1,102.57 over the estimated cost. This excess was due partly to the necessity for cleaning out and reconditioning the 6-inch pipe.

The cost per foot of pipe laid was as follows:

	Total Cost Per Foot	*Cost to City pr. ft.*
Removal of 3900 ft. 6" pipe and replacement with 10" and 12" pipe..	$6.58	$2.61
Relaying of 6" pipe, including the reconditioning of same.....	$3.15	$1.63

It was found after taking up the 6-inch pipe that it would be necessary to clean out and recondition it, due to the fact that it was badly tuberculated. It was also considered necessary to apply some type of lining to prevent a recurrence of the tuberculation. After investigating the feasibility of applying a lining locally, cement lining applied centrifugally was selected.

Since there were no facilities at hand to line the pipe in this manner, our forces set to work to construct such a machine. The cost of construction was about $350. The equipment consisted of two sets of two rollers, the sets spaced ten feet apart; one roller of each set was driven by a shaft extending from one set to the other. The shaft was belt driven by a small gasoline engine through a system of belts, pulleys and gears. A variation in periphery speed at the rollers, of 350 to 700 feet was obtained.

Considerable experimenting was necessary before our crew of green men became expert enough to get the cement grout to spread properly.

A trough was made long enough to pass through a 16-foot length of pipe. The cross sectional area of the trough was that required to hold the needed amount of cement grout to give a lining ⅛-inch thick over the entire inner surface of the pipe.

To place the fresh cement grout the trough was filled to the top [with a small amount of excess to allow for the cement adhering to the trough], inserted by hand, and dumped while the pipe was rotated slowly.

The trough was withdrawn as soon as the cement was distributed fairly evenly over the inner surface, after which the pipe was given a fast spin, approximately 700 peripheral feet per minute, for a period of from thirty seconds to one minute, after which the speed was reduced to about 350 feet per minute for ten to twelve minutes. During this period a current of air was directed through the pipe to hasten the evaporation of surplus water and speed up the setting up of the lining. The lining was kept wet by spraying for seven or eight days, after which it was ready to use.

The cost, exclusive of the cost of building the machine, was $0.16 for each linear foot of six inch pipe, and $0.104 per square foot of surface lined. This cost is considered high due to unskilled workmen, and other factors encountered by a small job and green men.

Flow tests on this watermain, made recently, indicate a Hazen and Williams "C" of 120. for a nominal diameter of six inches, or a "C" of 135.5 for a net diameter of five and three quarter inches. This compares favorably with cement lined pipe of first class workmanship. Flow tests were run by our Engineer, L. R. Burch.

Considerable work also has been done by this department in the study of the reduced carrying capacity of water mains through age, under conditions in this city. Several tests made by Mr. Burch would indicate that water mains in the vicinity of the pipe in question, and carrying the same class of water, suffered a loss in carrying capacity of 46% in the first eight years, or a decline in the H & W "C" of 58 points from an assumed initial "C" of 125.

Assuming that this pipe was in no better condition

than other pipes tested in the vicinity from which it was removed, we have permanently increased the carrying capacity of this pipe 53. points, or 79.3%.

The Tucson Water Supply

The Tucson water supply is obtained entirely from fifteen deep wells. Of the total, 80% is pumped from a group of eleven wells, four miles south of the city in the Santa Cruz Valley; 20% is pumped from a group of four wells within the city limits in the northeastern section.

The south side water has a total hardness of 240 p.p.m., while the north side wells produce water with a total hardness of 108 p.p.m. Recent analyses indicate a pH of 7.3 for the water on the south side, while the water from the northeast group of 4 wells has a pH of 7.7. The softer water of the north side group of wells is the more highly corrosive of the two waters and the growth of tubercles is much more rapid.

This water was among those discussed in the recent N. E. W. W. A. survey of "pipe line co-efficients, and the effect of the age thereon."

Failed Sewer in Rochester Replaced Without Delaying Traffic

By ELMER M. VAN GELDER
Supt. of Sewers, City of Rochester, New York

ON JULY 7, 1935, the western half of New York state suffered from torrential rainstorms and floods that resulted in much damage to highways, railways and other public and private property. On this same day, the city of Rochester experienced the heaviest rainstorm in its history, as follows:

Rainfall, 5 minute period, 0.47 inch
Rainfall, 10 minute period, 0.91 inch
Rainfall, 15 minute period, 1.25 inches
Rainfall, 30 minute period, 1.98 inches
Rainfall, 1 hour period, 2.09 inches

Naturally this overtaxed the sewer system of the city, for several hours, although the water soon subsided. However, three weeks later, on July 29, symptoms of trouble appeared when a break in a 10-inch domestic water supply line on West Main Street, near Prospect, occurred. Before the water could be shut off, a large area was flooded and it was necessary to suspend street car traffic until the tracks could be braced. These tracks carried three important city lines with a car passing approximately every minute. Vehicular traffic was restricted to one-way.

A careful investigation showed that the reason for the water pipe break was that it had been undermined by the failure and settlement of an old stone box sewer at this location. This old sewer, 3 feet high by 4½ feet wide, with plank bottom and stone slab top, had been built in 1878. It drains a large area, including one of the largest hospitals in the city. Weakened by the high pressure of the flood flow of three weeks previous, it literally "folded up."

Examination of this main sewer disclosed the fact that it was badly disintegrated and would probably have to be entirely rebuilt for a distance of about 70 feet. As this would have necessitated tying up vehicular and street car traffic for at least one month, some other solution to the problem was sought. Previous experience with bituminous-coated Armco corrugated pipe with paved invert in the city of Rochester had shown it to be especially well suited to quick, emergency replacement of sewers as well as for normal construction. So the next question was, how soon could a shipment of this pipe be obtained. A promise of 12-hour delivery time was made on 70 feet of 42-inch diameter, 10 gage Armco paved invert pipe.

The actual construction period involved 12 days rather than a month, and during this time there was very little inconvenience to traffic. A short trench was cut between the two tracks (see photo) and the pipe in 10-foot lengths was lowered by means of a truck crane. It was difficult to keep the bank from caving in, so we could take out only 11 feet of the old structure at a time and replace with 10-foot lengths of the corrugated pipe. Because the ground was soaked from the water main break, every minute counted, and every man had to know just what to do. The flow line is about 12 feet below the street level. Most of the 12 days was spent in excavating and in shoring the tracks. The actual time of installing the pipe was just 8 hours. Connection between the inlet end of the pipe and the old stone box sewer was made at a manhole while the other connection was made with brick.

Favorable comment was received from the officials of the New York Street Railway Company and from the people who depend on that service, for the manner in which the work was handled without serious delay to their cars. Had street traffic been cut off or detoured for a month, the merchants along the street as well as the traffic would have had cause to complain. The actual traffic count between 7 a.m. and 7 p.m. on April 21, 1935 was 10,751 vehicles.

The work of placing the pipe was under the direction of the writer, superintendent of sewers for the city of Rochester.

Night work in replacing Rochester sewer

The Editor's Page

Water Supply and Disease:

Upon the sanitary control of water supplies rests, to a very large degree, the health of our communities. We doubt if the realities of this fact are recognized generally; too many are prone to look at waterborne disease as a thing of the past. It will come as somewhat of a shock to these complacent folks to know that some of the largest epidemics of this type have occurred within the past ten years. Among public health workers it is appreciated that a breaking down of present standards of water quality would bring back the high disease rates of thirty or forty years ago.

In the safeguarding of water supplies there can be no slip. A water safe 364 days a year is not enough; safety must be absolutely continuous. To accomplish this continuous safeguarding, several things are necessary. First, there must be a complete recognition on the part of the community officials, of the waterworks operators and of the public of the danger of contaminated water. Second, there must be adequate provision for personnel and equipment throughout the entire twenty-four hours of each day. Third, there must be dependable apparatus for treating the water, with provision for standby or emergency equipment if and when needed.

The *potential* dangers of waterborne diseases have actually increased in the past decade or so. Fewer people are immune to typhoid fever, for instance, because of having had the disease, and fewer still because of having been inoculated. There is thus more tinder for the fire, more opportunity for infection if the line of defense should break. There is also a greater proportion of the population served by water supply systems than ever before.

During the past few years many new waterworks systems have been installed, largely in very small communities that may not yet be fully educated to the necessity of providing a pure water *all the time*. It is going to be largely up to the engineering departments of the state boards of health to educate these communities, and to cooperate with them in setting up a barrier through which disease cannot penetrate. Unfortunately, practically all of these engineering departments are undermanned; no matter how able a man may be, he can be in only one place at a time.

Public health leaders and the water supply industry should cooperate in carrying on, with added emphasis, the work of educating, and of keeping educated, the responsible officials and the public as well, to the value and to the responsibilities of a public water supply.

It Looks Like Snow:

Let us hasten to add that this is not a weather prediction for the next few days. As a matter of fact, when this issue is being read, many of our subscribers will be coatless—maybe shirtless—and enjoying (or craving for) a large electric fan. It is merely a reminder that winter will come again; that in a few months, or less in some areas, snow removal will be the most immediate problem of many engineers.

Planning must be done before snow comes. Doubtless a lot of folks found that out last winter, when many sections had about the heaviest snowfall for nearly half a century; doubtless also the experience, gained last winter will help in this and coming winters.

One of the most important phases of planning relates to equipment. Last winter, the editor of this magazine wrote to more than a hundred typical state, county and city engineers about their snow removal work. Over and over again came the same story—of old and worn-out equipment, broken down in the first real emergency; of new equipment ordered by wire, most of which "arrived too late to help us this year."

Now is the time to run an exceedingly critical eye over the more or less graceful outlines of the trucks and tractors and plows that you are going to have to use next winter; look up their birth certificates and see how near to the mechanical equivalent of three score and ten they are; call in your most pessimistic mechanic and get his opinion of them; and then plan how you are going to wangle some new equipment for early fall delivery out of the appropriating authority.

Beyond the Sewer Lines:

Our cities and their engineers have quite generally provided sewers to serve a considerable proportion of the population. Municipal funds and engineering talent have been available for financing and designing these works.

But what of the areas not reached by sewers? The areas not thickly enough populated to be sewered; or so located as to be difficult to reach. The general trend has been to wash the financial and technical hands very thoroughly of responsibility for these, and to leave to the individual the entire problem of providing sewage disposal. Then, through the health departments, a more or less gentle prodding is provided to stimulate action.

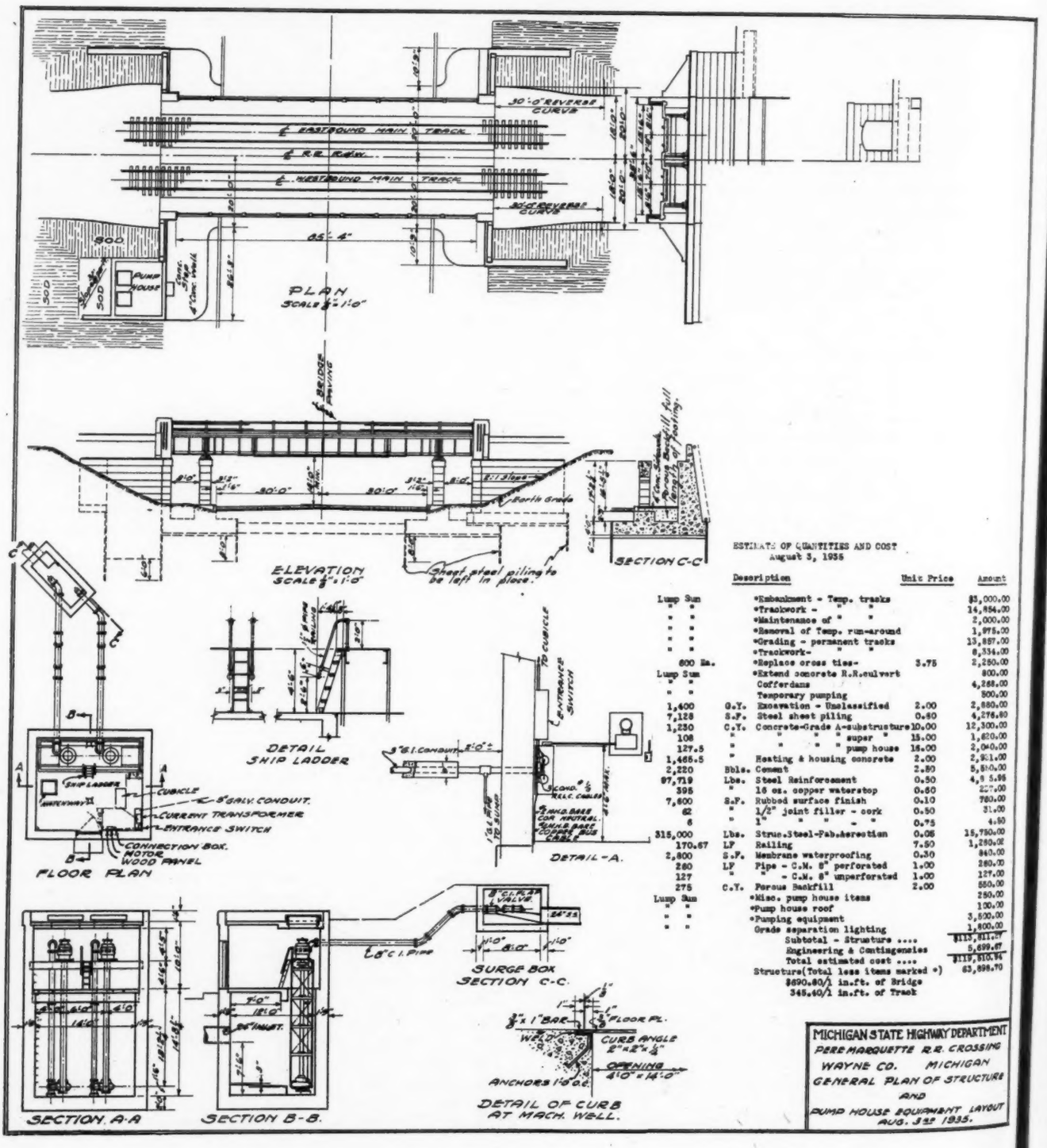
We agree very thoroughly with Mr. Hazlehurst, who presents some brand new thoughts along this line on another page. The folks beyond the reach of the sewer lines are just as much entitled to aid as are those served by the sewers; they need just as much and just as good —maybe better—technical advice. After all, the health conditions in these areas affect most materially the health conditions of the entire community.

City engineers for the most part have declined to become interested in such small items as sanitary toilets and small septic tanks. It is time to change this attitude. It is time to approach the matter of sewage disposal from a community-wide viewpoint. Every possible residence ought to be served by means of a sewer, and those residences that cannot, for the time, be provided with sewerage service, ought to be provided with some adequate substitute as a matter of community health and prosperity.

A Michigan Grade Crossing Elimination

The drawing below shows some of the details of an underpass in Michigan, including the layout of the storm water pumping station. The structure was designed for Cooper's E-70 loading, with dead load of 6500 pounds per lin. ft. of track. The pavement width under the bridge is 60 feet, and provision is made for 8-ft. sidewalks on either side. Estimated cost data are given on the drawing.

This job was described and illustrated in a recent report of the Bureau of Public Roads giving details of design and cost data on a number of typical grade crossing eliminations.



Description		Unit Price	Amount
	Lump Sum		$5,000.00
	" "		14,854.00
	" "		2,000.00
	" "		1,975.00
	" "		13,857.00
	" "		8,334.00
	600 Ea.	3.75	2,250.00
	Lump Sum		800.00
	" "		4,268.00
	" "		300.00
C.Y.	1,400	2.00	2,880.00
S.F.	7,128	0.60	4,276.80
C.Y.	1,230	10.00	12,300.00
"	108	15.00	1,620.00
"	127.5	16.00	2,040.00
"	1,465.5	2.00	2,931.00
Bbls.	2,220	2.50	5,550.00
Lbs.	97,719	0.50	4,885.95
"	395	0.60	237.00
S.F.	7,600	0.10	760.00
"	62	0.50	31.00
"	6	0.75	4.50
Lbs.	315,000	0.05	15,750.00
LF	170.67	7.50	1,280.02
S.F.	2,800	0.30	840.00
LF	280	1.00	280.00
"	127	1.00	127.00
"	275	2.00	550.00
C.Y.	Lump Sum		250.00
	" "		130.00
	" "		3,500.00
	" "		1,800.00
	Subtotal - Structure		$115,811.27
	Engineering & Contingencies		5,699.67
	Total estimated cost		$119,510.94
	Structure(Total less items marked *)		63,898.70

$690.80/1 in.ft. of Bridge
345.40/1 in.ft. of Track

Some Suggestions for Painting Steel Water Tanks

THERE are two main types of steel protective paints. The one generally used on steel subject to weather exposure consists of coating of clean metal with a basic rust-inhibitive primer paint, such as basic lead chromate, red lead, blue lead, a combination of one or more of these pigments; or their combination with some other stable pigment, such as red oxide of iron, in order to produce a cheaper, but still serviceable paint. A rust inhibitive priming paint should contain as much pigment and as little vehicle as possible. The oil is the weakest part of the paint film, and any excess in addition to the amount which becomes permanently fixed by the pigment will only weaken the paint structure. This large ratio of pigment to vehicle will also produce that flat surface which is desirable in a primer coat, as it provides a better bond with the next coat.

The top paint coats serve to protect the primer as well as the metal itself. A good primer is not necessarily a good weather resisting paint, and needs as much protection as possible. The less defensive work the primer is called upon to do, the longer it will last. For this reason, a water-proof paint is desirable for the final paint coat, but weather resistance should not be sacrificed merely to obtain water tightness. A paint which is water-proof when new, but which soon breaks down, would be a poor investment. A paint for service must be able to withstand practically all extremes of climatic conditions. A paint which would give excellent service in the tropics might be a total failure in a cold climate, and paints which are exposed to wide extremes in temperature and humidity require a vehicle especially adapted to such service.

Among the best types of pigments for weather resisting top coats has been found by experience to be flake graphite, flake aluminum and hematite or micaceous iron ore. Sometimes two or more of these pigments are combined to produce a paint of exceptional quality.

A type of pigment which is used a great deal in the interior of water storage tanks for municipal water supply service, on account of its taste-free properties, is a natural asphalt such as gilsonite, rock asphalt, lake asphalt, or a combination thereof. These pigments are incorporated in the same type of weather resisting vehicle as should be used for the other types of pigments for weather resisting steel paints.

The second general type of paint for the protection of metals consists of a homogeneous coating of cut-back and fluxed coal-tar or asphalt or of emulsified asphalt. Such paints depend entirely on their waterproof properties for the protection of the metal. Asphalt paints are cut with naphtha, sometimes fluxed with lighter oil asphalts, and if a hard surface or high gloss is desired, may contain some gilsonite. Coal tar paints should be made with refined neutralized coal tar, fluxed with a sufficient amount of non-volatile creosote to produce as elastic a paint film as possible, and thinned to the proper consistency with a suitable volatile solvent.

Straight emulsions, as distinct from chrome emulsions, are not generally considered to be very desirable for application on iron and steel, although they serve very well in some applications on concrete. Reinforcement of bituminous paints with aluminum powder is desirable for coal tar and asphalt paints exposed to weather, as it materially increases the opacity of the paint film, thus decreasing the destructive effects of sunlight. Aluminum powder reinforcement of bituminous paints also reduces the shrinkage of the paint film with its resulting checks and cracks. The checking of coal tar and asphalt paints is largely due to the slow evaporation of the flux from the paint. The aluminum tends to reduce this evaporation.

Coal tar paints, along with all other phenol products including Bakelite paints and enamels, should be kept away from chlorine, or from water containing residual chlorine in any amount, no matter how small. This means that coal tar or Bakelite is not a desirable paint for use in elevated storage tanks or standpipes connected to a chlorinated water supply.

Because of the ability of red lead to form a workable paint with less oil than any other pigment, and its further ability to fix this oil to a condition in which it is not materially affected by the action of water, it has become the standard practice of engineers to use red lead paint for under water work as much as possible. For priming coats in steel water tanks and submerged steel work, as heavy a red lead paint as can be properly worked should be used. A heavy paint does not mean a thick film however, and a 33 pound red lead paint should be brushed out to as thin a film as a paint containing half this amount of lead. Pure red lead is a very slow drying paint, and it is advisable to add litharge as a dryer, if fast drying is desired, rather than adding turpentine. Litharge hardens the paint and it is advisable that red lead paint for submerged service contain about two pounds of litharge per gallon of paint. The litharge must be added as the paint is used, as it quickly hardens the paint in the container. Three coats of red lead paint in a pure linseed oil vehicle, the paint weighing not less than twenty-six pounds per gallon after mixing and containing two pounds of litharge per gallon, will provide about the best under water protection that is possible, provided that each coat is well brushed out and allowed to become thoroughly hard before applying the succeeding coat or placing in service, and also provided the metal was dry and clean when painted. The litharge content of the pigment not only accelerates the hardening of the paint, but produces a paint film which is harder and more resistant to the softening effect of water. This hardening of the paint with litharge is not desirable for paints subjected to weather exposure and the use of litharge in red lead paint is not generally recommended except for submerged service.

The principal reason that asphalt pigments for field paint coats for the interior of water supply storage tanks are generally specified instead of red lead is that it is difficult and impracticable in most cases to permit sufficient time to elapse between successive paint coats and prior to placing water in the tank to permit complete hardening of red lead paint. If water is placed in a tank before the red lead paint has become completely hardened, objectionable tastes will be given the water, and these tastes may continue for a long time.

There is another objection to the use of red lead paint, and that is the possible solution of lead products in the drinking water.

Aluminum paint is fast becoming the standard paint for all exposed exterior steel surfaces and for many interior installations. Aluminum paint possesses more advantages for this service than any other one type of paint.

Coal tar paints, if of good quality, provide better protection than any other type for use underground, submerged in water or for damp locations where the temperature variation is within a range between thirty-five and ninety degrees Fahrenheit. For temperature conditions outside this range, asphalt paints are recommended for use under conditions not suitable for oil vehicle paints.

Preparation of the Surface

Proper preparation of surfaces prior to painting is of great importance, especially where repainting is to be done. In painting new steel or iron, the best possible surface preparation is sand blasting. This is so inconvenient and expensive that it is seldom done, although it is sometimes the cheapest way to clean up an old structure for repainting. It is not necessary to remove all adherent rust from steel before painting but it is essential that all rust and scale that vigorous wire brushing will loosen be removed. A tightly adherent coating of rust, such as can be found on old cast iron, is a good protection in itself, provided that it is absolutely dry when covered. Painting over rusted steel should be done only in hot dry weather, and then only during the middle of the day when the humidity is the lowest. Old paint should be entirely removed from steel prior to repainting, unless it is intact and free from blisters and rust. Tightly adherent portions may be left, but the edges should be sandpapered to a flat smooth surface, as any abrupt break in a paint film is a point of weakness where shrinkage stresses are concentrated. In addition any surface irregularities will be magnified on the finished surface. One place above all others which is a point of weakness in old fabricated steel structures is the abutting surfaces in riveted connections. Great care should be taken to remove all paint from the edges of these surfaces and if these connections can be cleaned up sometime in advance of the painting proper, it is often advisable to apply a small amount of fish oil along the junctions of members and gusset plates in two successive applications a day apart and allow this fish oil to dry for not less than a month before coating with paint. If it is not possible to wait that long, then all surplus oil should be wiped off two or three days after the final application. Fish oil has remarkable penetrative properties, and will continue to penetrate the joint for a long time.

All surfaces should be absolutely dry when painted, and free from all dirt, dust, sand, mud, oil, grease, rust, loose mill scale, or other objectionable substances. All rust and loose mill scale should be removed with a steel brush and sandpaper. All grease or oil should be removed with gasoline, followed with sandpaper. All paint damaged or made brittle from the effect of heat of welding or riveting should be removed back as far as necessary from the weld or rivets, finishing with sandpaper and feathering the edges of the sound paint.

General

Priming coats for steel work should always be applied with a brush and spray applications of red lead paint should not be permitted. It is essential that a thin, well brushed paint film be provided, which is impossible to obtain with spray equipment handling heavy red lead paint. Red lead paint weighing twenty-six pounds per gallon should be brushed out to provide a coverage of not less than 500 square feet per gallon of paint.

No paint should be applied, except under shelter, during wet, damp or foggy weather, early in the morning before dew has evaporated, or when conditions are such that wind-blown dust, dirt, debris or insects will collect on, and adhere to, the freshly applied paint. All paint applied with air spray equipment should be protected, during application, from being deflected or carried away by the wind, to the damage and detriment of the nearby premises. No paint should be applied in an air temperature of, or below, forty degrees Fahrenheit, or to surfaces of metals (such as the surface of a tank containing cold water), which have a temperature of, or below, forty degrees Fahrenheit, regardless of air temperatures, or when the metal temperature and atmospheric conditions are such that condensation is formed on the weld.

All paint, in any one paint coat, should be hard and dry through the entire paint film before the next coat is applied or before submerging in water. Paint films which show sags, checks, blisters, tear drops or fat edges should not be accepted, and any final coat of paint which shows these defects should be entirely removed from the member or unit involved and the surfaces repainted.

The last and probably the most important suggestion which I have to offer is this: On all work of any particular importance, and especially on work erected by steel fabricators and tank companies, be sure that all paint is applied by professional painters who are experienced and competent.

The above is part of a paper before the Kansas Water and Sewage Works Ass'n, by C. I. Dodd (of Black & Veatch, consulting engineers). In a paper before the Virginia Section of the American Water Works Ass'n, C. F. Harris (division manager, Detroit Graphite Co.) gave suggestions along the same general lines, with the following additional points:

1. Paint should be delivered to the job in unopened packages plainly identified with the manufacturer's label.
2. Paint should not be stored in open packages. Exposure in open cans is detrimental.
3. Only thinners recommended by the manufacturer should be used, and only in the proportions suggested by him.
4. Do not apply successive coats before preceding coats have thoroughly dried. An attempt to save time by hurrying will cause the paint to skin over and early failure will result.
5. Spot and priming coats should be thoroughly brushed out. This is particularly important at plate laps and around rivet heads.
6. Use good brushes, or if applied by spray, be sure air pressure is thoroughly atomizing the paint.
7. All paint should be thoroughly stirred and boxed just before application.

A good job consists of three coats inside and three coats outside. If the work is done before the base coat is exposed to the point of deterioration, you can save expensive cleaning and the cost of one coat.

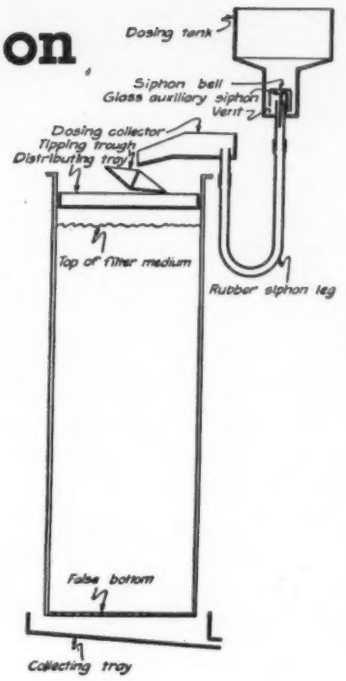
The intermediate coat gives an added thickness which may mean an extra two or three years' service. It costs less to apply while the job is in progress than another coat would cost later on if applied alone. Another advantage is that it acts as a stabilizer between the hard drying inhibitive prime coat and the long oil or elastic finish coat, preventing cracking or peeling due to expansion and contraction under temperature changes.

Treating Creamery Wastes on Trickling Filters

INVESTIGATIONS of the factors underlying the treatment of creamery wastes have been in progress for a number of years at the Iowa Engineering Experiment Station. In 1923, it was shown that an activated sludge could be produced for creamery waste. This process showed a high degree of purification, but the aeration period required was very long; it was not judged that this method would be economimal for small installations. In 1926, results were reported on lath trickling filters. At rates of 1.5 to 2.5 mgd per acre, an effluent was obtained that would not become acid.

Since lath filters are not practicable for large installations, the work was continued, using other filter materials. These were reported in Bulletin 124, published in December, 1935, covering work done principally during the period 1925 to 1930. The data presented in this report, which was prepared by Max Levine, G. H. Nelson and H. E. Goresline, are abstracted herewith.

The filling materials used included laths, cinders, quartzite, gravel, spiral ring packing, broken burned clay tile and corncobs. The filters were 2 feet square and 6 feet deep. The waste treated daily consisted of 50 gallons of various dilutions (0.5% to 3.5%) of skim milk, applied at the rate of 150 to 200 cc per min. This is about 650,000 to 850,000 gal. per acre per day. The waste was applied for a period of 20 to 16 hours, respectively, the 24-hour rate therefore being about 550,000 gpd per acre. This dosing simulated conditions at many small creameries.



Dosing tank, siphon, distributor and experimental filter used.

Lath and Cinder Filters

The lath filter consisted of 6 sections of ordinary wood building laths, each section being 2 feet square and 1 foot deep. A space of 4 inches was provided between sections for aeration and sampling. The laths were placed flatwise, 1.25 inches apart, with alternate layers at right angles. A perforated metal tray was used as a distributing device. The cinder filter was similar, consisting of 6 sections 4 inches apart, with the bottom of each section made of slats to hold the cinders. Cinders were of such size that they were retained on a ½-inch screen; some were 3 to 5 inches in largest dimension. These larger pieces were usually placed at the bottom.

The average reduction of oxygen consumed on the lath filter was 75.5%; and for the cinder filter 85.7%. The average ammonia content of the applied waste was 1.35 ppm.; of the lath filter effluent 0.53 ppm.; and of the cinder filter effluent 0.33 ppm. The average nitrate content of the applied waste was 1.31 ppm.; of the lath filter effluent 5.40 ppm.; and of the cinder filter effluent 12.83 ppm. The applied waste has a pH initially of 6.74, and after anærobic incubation for 48 hours at 20° C of 5.98. The lath and cinder filter effluents showed reactions of pH 7.80 and 7.66; after incubation the reactions were 7.58 and 7.38, respectively. After the first two weeks of operation, practically all of the cinder filter effluents showed relative stabilities of over 90%, while only 40% of the effluents from the lath filter showed such stabilities. The mean oxygen demand of the applied waste was 565 ppm.; of the lath filter effluent 28.9 ppm.; and of the cinder filter effluent 13.6 ppm. The uniformity of the cinder filter were strikingly greater; no clogging was observed in either filter during the 4-month period of observation.

Gravel and Spiral Ring Filters

In this series of observations, the filling material of one filter consisted of thoroughly washed gravel, retained on a ¼-inch mesh screen, and varying in size up to about 1-inch. The other filter consisted of 6 feet of 3-in spiral ring packing such as has frequently been employed in absorption towers. The dosing rate, periods of rest, and dosing cycle were the same as those previously described, and the concentrations of waste were about the same as those for the lath and cinder filters.

The average concentration of the waste as applied, on an oxygen consumed basis, was 538 ppm. The corresponding figure for the effluent of the gravel filter was 59 ppm., a reduction of 88.4%; and of the spiral ring filter 134 ppm., a reduction of 72.5%. The organic nitrogen content of the applied waste averaged 69.4 ppm., of the effluent of the gravel filter 5.6 ppm., and of the effluent of the spiral ring filter 20.6 ppm. The average ammonia content of the applied waste was 0.53 ppm., of the gravel filter effluent 0.81 ppm., and of the spiral ring filter effluent 4.09 ppm. The average nitrate content of the applied waste was 1.13 ppm., of the gravel filter effluent 13.79 ppm., and of the spiral ring filter effluent 6.84 ppm. The applied waste had an average pH of 6.71; the gravel filter effluent had a pH of 7.82 and the spiral ring filter effluent a pH of 7.68. After the first week, the gravel filter effluents showed relative stabilities of over 90%, which were maintained until after the 12th week when highly concentrated waste was applied, after which stabilities dropped to less than 25%. The spiral ring filter effluents never showed stabilities higher than 50%, and rarely higher than 25%. The average oxygen demand of the applied waste was 513 ppm., of the gravel filter effluent 15.5 ppm., and of the spiral ring filter effluent generally between 40 and 100 ppm.

Corncob and Broken Tile Filters

In this set of observations, the filters were 2 ft. square and 6 ft. deep as in the preceding series, but the body

of the filters was constructed of galvanized iron and the filling materials were supported by 1-inch galvanized iron pipes placed 1 inch apart. The filling material consisted of about 6 inches of quartzite (2 to 3-inch size) placed directly on the pipes, over which was placed 5.5 ft. of thoroughly washed broken tile ½ to 1½-inch pieces; the other filter used, instead of the broken tile, 5.5 ft. of corncobs broken to about a 2-inch length. The rate of application and the dosing cycle were the same as previously employed on the cinder, lath, gravel and spiral ring filters. The waste was about 50% more concentrated, with an approximate oxygen consumed value of 760 ppm.

With an average oxygen consumed value of 763 ppm. of waste, the corncob filter effluent was 119 ppm., and the broken tile filter effluent 48 ppm. The applied waste ammonia content was 1.80 ppm., of the corncob filter 3.05 ppm., and of the broken tile filter 2.24 ppm. The average nitrate content of the applied waste was 1.97 ppm., of the cob filter 0.51 ppm., and of the tile filter 18.10 ppm. The reaction of the applied waste was pH 6 6, of the cob filter 8.1, and of the tile filter 8.2. Approximately 65% of the tile filter effluents were stable, whereas the cob filter effluents were unstable, generally having a relative stability of less than 20%. The oxygen demand of the applied waste was 761 average, generally running between 600 and 900, of the cob filter effluent 63 ppm., and of the tile filter effluent 31.5 ppm. This series of experiments ran about nine months, at the end of which time the tile was disintegrating, and there had been trouble with ponding. This ponding was not affected by chlorination, but was relieved by turning over the top 12 to 18 inches. The corncob filling was a jelly-like mass in the upper portion.

Variations in Dosing Cycles

Using the same type of iron-body filter, work was continued with cinder (⅝ to 3- or 4-inch material) and quartzite (1- to 3½-inch material) filters to determine the effect of variations in the dosing cycles. In general it was found that variations in the dosing cycle from about 2½ to 22 min. produced little effect on efficiency of the fine cinder filter, while with the quartzite the reduction decreased as the dosing cycle increased. Reduction of 95.5 per cent in oxygen consumed with the 2½-min. cycle dropped to 89.7 per cent for the 10-min. cycle and to 81.7 per cent for the 22-min. cycle on quartzite. The amount of nitrate was not appreciably affected by the dosing cycle.

The organic nitrogen content of the effluent, the oxygen consumed and the oxygen demand increased with increasing dosing cycle, whereas the ammonia and nitrate content were relatively constant. This marked fluctuation of oxygen consumed and oxygen demand, coupled with the relative constancy in ammonia and nitrates, is considered an indirect indication that some of the wastes were short circuited with the long cycle on quartzite.

The rate of runoff of the effluent from the cinder filter was very constant and independent of the dosing cycle. This was in marked contrast to what was observed with the quartzite filter. Thus with a dosing cycle of 10 to 12 min. the average time of discharge of 250 c.c. from the cinder filter was 89.1 ± 5.29 sec., and for the 22-min. cycle it was 87.3 ± 12.26 sec., the coefficients of variability of the rates of discharge of runoff being 5.94 per cent and 14.04 per cent during the 10- to 12-min. and 22-min. cycles, respectively.

For quartzite the time of discharge of 250 c.c. during the 10- to 12-min. cycle was 88.3 ± 37.18 sec. (coefficient of variability 42.1 per cent); increasing the dosing cycle to 20 to 22 min. resulted in a still greater variability in the rate of runoff, the average being 85.9 ± 97.20 sec. (coefficient of variability of 113 per cent).

Conclusions

Cinders were found to be very efficient as a filter medium for treating creamery wastes but they were observed to clog after operating for a period of about five months. Presence of hard water salts did not affect the efficiency of a cinder filter.

Although the results obtained with the 3-in. spiral ring packing were not as good as on other filter materials they were nevertheless unexpectedly highly efficient, indicating that smaller-sized ceramic rings would be particularly satisfactory.

Corncobs were quite effective in removing organic-nitrogen and oxygen-demanding constituents but there was no evidence of nitrification, and the life of the filter was limited by disintegration of the cobs.

With small-sized filling materials the dosing cycle was not found to influence purification efficiency appreciably. With a coarse filling material the short dosing cycle gave much better effluents than the long cycles (10 min. or longer). With long dosing cycles on coarse material sewage surged through the filter.

On the coarse-grained filters short cycles of 3 or 4 min. produced higher purifications, more uniform rates of runoff, and more uniformly constituted effluent than did cycles of approximately 20 min.

Distillery Wastes

Investigations by the New Jersey State Board of Health on distillery wastes from plants manufacturing apple and fruit brandies, show the following pollution loads:

Total solids	from 9.958 ppm. to	36.689 ppm.
Total solids in solution	from 9.850 ppm. to	36.567 ppm.
Total organic solids in solution	from 8.542 ppm. to	31.516 ppm.
Acidity	from .816 ppm. to	4.440 ppm.
Oxygen consumed	from 5.990 ppm. to	14.800 ppm.
B.O.D.	from 2.182 ppm. to	5.991 ppm.

The majority of the distilleries inspected operate from September to February of each year and the liquid wastes are discharged intermittently from fill and draw stills. Unless a very high dilution factor prevails in a stream receiving these wastes, a serious nuisance results. However, many of the small plants are so located that sufficient land is available to dispose of the liquid wastes by lagooning and broad irrigation. On upland streams, the water of which is later used for public water supplies, wastes are excluded from the waters. The disposal of the wastes by broad irrigation, the seasonal operation and the location of the plants have combined to reduce nuisance.

Several of the large plants are still faced with the problem, however, and laboratory experiments have given little encouragement as to methods of treatment.

A secondary source of stream pollution is the pulp remaining after extraction of the juice. This pulp, known as pomace, is stored in large piles on lands draining into the streams. One distillery has been converting its pomace into "bacterial fertilizer."

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The International line includes TracTracTors, wheel tractors, and power units, with gasoline and Diesel engines. The power units range in size from 12 to over 100 h. p., and there are light-duty engines from 1½ to 5 h. p. Keep this fact in mind also—no matter where your jobs are, International factory-standard service is close by to keep this equipment on the job. For detailed information, call on the nearby Company-owned branch or authorized industrial dealer.

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When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 55-57.

Studies of Lighting on a Miniature Highway

A MODEL highway to a ⅛ scale was built by Kirk M. Reid and H. J. Chanow, street and highway lighting specialists of the Nela Park Engineering Department. The actual length was 250 feet, or the equivalent of 2,000 feet of highway. Five different types of pavement, as well as three lighting systems—sodium vapor, mercury vapor, and incandescent—separately controlled and flexible as regards lamp size, spacing, mounting height, arrangement, transverse position and light distribution, were provided.

Studies carried on related to the relative "seeing value" of light of different spectral qualities, as well as glare and distribution. The facts determined by the work were summarized in a recent paper by Dean M. Warren of the General Electric Co. in a talk before the Cleveland Engineering Society, as follows:

(1) With a representative highway-lighting system, objects are seen as silhouettes at over 80% of the locations on the roadway. It is, therefore, desirable to so light the pavement that all parts of it appear, substantially, as uniformly bright when viewed from the position of driver or pedestrian. A light-colored mat-surface pavement offers the best visibility and safety by night, whether the illumination is provided by fixed highway lighting or by automobile headlights.

(2) When using the same amount of light similarly distributed from sodium-vapor, mercury-vapor, and incandescent lamps, one sees objects of interest from the standpoint of safety just as far away and just as soon with one kind of light as with the others. There is no difference in the ability to detect the presence of an obstacle or to discriminate between hazards. This result has seemed surprising to some because of the known advantage of sodium-vapor light in the discernment of the finest detail—that is, near the limit of resolution for the eye. However, in driving down a highway one is not concerned with the detection of an object one-third of an inch high at a distance of a hundred feet.

(3) With a light-distribution representative of current highway-lighting practice, the glare from the equipment was found to interfere with seeing to such an extent as to waste as much as half of the illumination. This loss in seeing value is much greater than is generally recognized, and is in addition to the discomfort and distracting influence of glare.

(4) A highway with a uniform horizontal illumination throughout its length presents a large variation in brightness when viewed by driver or pedestrian. For uniform brightness, the light must be distributed to take account of the specular or direct reflection of light at small angles from the surface, which is pronounced even in the case of the more mat pavements. This requires a more exact and complete control of the light flux than has been had with past types of highway-lighting equipment. Light striking the pavement in a direction away from the observer is of little value in building pavement brightness. It is the light coming to the pavement and reflected toward one that is effective.

(5) Using the standard pole spacing of 125 feet it is feasible to obtain this high order of brightness uniformity economically and at the same time to shield the sources sufficiently to obviate, to a very large extent the seeing loss from glare.

The Reid-Chanon researches have led to the development of a new and radically improved safety-lighting system. This installation is on Route 422 about a mile beyond the intersection of Kinsman and SOM Center Roads.

The gain in safety achieved under the new system may be appreciated from the fact that the seeing it provides could be equalled under past systems only with several times as much light.

Three outstanding features account for the great gain in seeing:

(1) The proportion of the generated light reaching the pavement and shoulders is double that obtained from former equipments.

(2) Glare is suppressed by completely shielding the light sources to approximately 10 degrees below the horizontal.

(3) The road surface presents an altogether higher order of uniformity of brightness, free from areas of low visibility.

In short, one sees quickly and surely; headlights are much less glaring: one drives in comfort and walks in safety.

Salvaging a Curb and Gutter With a Mudjack

By HARRY L. STEVENS
City Engineer; Clay Center, Kans.

THE most interesting job in Clay Center last year was the salvaging by the use of a mudjack of several hundred lineal feet of 36-inch combined curb and gutter which was originally laid on a very flat grade. We also raised several hundred square yards of concrete pavement to the original grade.

The procedure in this work consists of the following operations: Drilling holes through the slab to be raised; placing the discharge nozzle of the mudjack in these holes; and pumping the mud under the slab to be raised. The mud is prepared in a small concrete mixer and the preparation is very similar to mixing concrete. We found that we had the best success by using only such soil as would pass a ⅜-inch mesh screen. Most suitable proportions were obtained by adding one shovel of ordinary portland cement to each nineteen shovels of the soil. The cement is required to offset the tendency of the soil to shrink as it dries. The mixture for the best results should be of the consistency of rather thick gravy.

The costs vary per square according to the amount that the particular spot is out of grade. On the work we did last year we found that the average cost per square yard was between twenty-five cents and thirty cents, to which is to be added the small cost of trucking soil and cement, and cleaning waste from the job. We found the most satisfactory soil for mixing and use in the mudjack to be a loam free from sand and clay.

Lights Near Construction Work Reduce Hazards of Night Driving

Recognizing that construction work at the intersection of the old and new highways would add to the danger of night driving, E. D. Sterner, safety highway commissioner of New Jersey, has eliminated the hazardous condition with an installation of nine highway lights south of the Victory Bridge approach at South Amboy.

The lamps, of a new type recently announced by General Electric, which double the light output on the roadway given by conventional units, are spaced 300 feet apart and mounted at 25 feet height on one side of Route 4. The temporary lighting is between two permanently lighted areas. On the north is the lighted Victory Bridge approach, and on the south are the lighted streets of the city of South Amboy.

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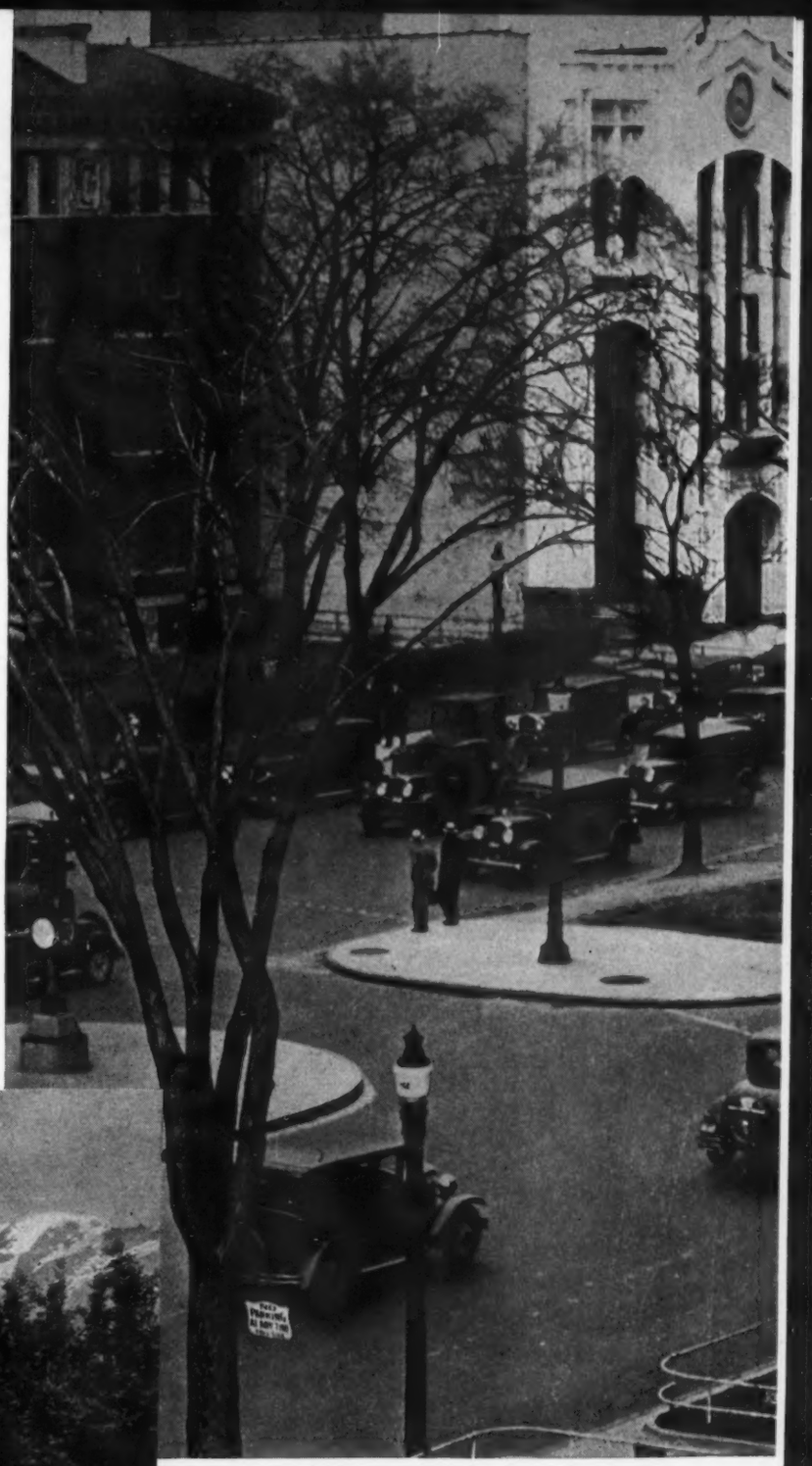

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IN LONG-WEARING ROAD MILES . . . IN DISTRIBUTION OF LABOR . . . IN TAXPAYER SATISFACTION

Iron and Manganese Removal by Catalytic Reagents

By W. G. KIRCHOFFER
Madison, Wisconsin

THE purpose of this paper is to briefly discuss a relatively new process of iron and manganese removal accomplished by a catalyst. The data presented have been accumulated from a somewhat limited experience in this field during the past twenty years.

As I see it, waters bearing iron and manganese can be logically divided into three main classes:

(1) Those waters which begin to precipitate iron and manganese on exposure to air; usually hard waters containing carbonates or sulphates or both.

(2) Those waters which will hold iron and manganese in solution indefinitely even when aerated, the elements usually combined with organic acids and appearing in the colloidal form.

(3) Those waters which contain iron or managanese or both in each of the above forms and therefore a part, but not all, of the element is deposited after aeration and cannot be removed entirely by simple filtration through sand.

The process which I am about to discuss applies more particularly to the second and third types of waters, but can be used on the first type if desired.

Waters containing manganese are more difficult to treat than those which contain only iron. Manganese is seldom found alone. Where the same processes are effective for both iron and manganese, the reaction is slower for manganese. In a water containing both iron and manganese, the iron will be found deposited near the source, while the manganese will be found on the outskirts of the system and in dead ends. Manganese is a much more troublesome element than is generally supposed and is so near like iron in its effects that often its presence is not discovered until it is learned that ordinary removal methods are ineffective. When present with iron, organic matter, carbonic acid or organic acids, it is a most difficult element to remove.

It has been found that the higher oxides of manganese appear to have a very favorable effect on the removal of those of a lower order, so that if water containing manganese is applied to a filter in which higher oxides have been precipitated, a large percentage of the manganese in the water will be removed. Such a condition can be brought about by treating the filter with manganese sulphate, sodium hydroxide and a hypochlorite, or by letting the filter become automatically coated, as it will do in most cases if not disturbed for a long time.

As an example; many years ago the Mt. Vernon, Illinois, city water supply and the Anna Hospital in Southern Illinois tried at first to take out the iron and manganese by sand filtration, but were unsuccessful. In time the sand became coated, resulting in fairly good removal. Similar experiences were had at the Marathon Paper Mills, near Wausau. The black manganese-coated sand is better than new and should not be removed.

It was this action that influenced the writer (as it no doubt has other investigators) to try the use of material such as pyrolusite (manganese dioxide rock) to aid in the removal of this most troublesome element. This process in chemical language is a catalytic one, in which the removed manganese acts as the catalyst.

It was formerly thought that this action was brought about by the mere contact of an agent, but it is now believed that reactions are attended with the formation of intermediate compound or compounds such as the higher oxides of manganese, so that by the alternate composition and decomposition of them the agent is left unchanged.

I first tried out this process at Wausau, Wis., where there is a water of the third type, low in alkalinity and pH, but high in iron, manganese and organic matter. As the water needed aeration, a tray aerator, with manganese dioxide rock placed in the trays, was tried out. It did not remove all of the iron and manganese, but aided greatly in their reduction and flocculation. A plant using this principle of a capacity of 5½ million gallons per day was constructed, but it had to be followed by the use of lime and alum to take out the portion held so tightly by the colloidal organic matter. The sand filters which followed the chemical treatment have since become coated with the higher oxides of manganese to such an extent that the chemical dosage has been cut approximately 25%. In time the tray aerators containing the manganese became badly clogged with the more or less freely bound elements and caused difficulty in keeping the aerators in action.

Since this plant was built I have experimented with beds of Pyrolusite direct from the mines in sizes ranging from ½" to 1". This material was placed in a closed vessel filled with the water to be treated and air in finely divided bubbles was applied at the bottom. It required only 20 minutes of such aeration using only .07 of a cubic foot of air per minute per square foot, followed by sand filtration, to remove the elements to less than .1 p.p.m., and 10 minutes' aeration removed them to a satisfactory limit.

A plant using this principle followed by sedimentation and filtration through sand has been designed (but not as yet built) for a paper mill community. Since then experiments have been run in Madison by a laboratory using manganese ore crushed to the size of coarse filter sand. It was found that the process worked successfully until the filter became loaded with the iron and manganese deposits and then it was difficult to back-wash the filter due to the weight of the medium.

It has been found that equally good results can be obtained using synthetic material as can be had with the genuine ore. For instance, I took a quantity of anthracite coal of filter sand size (about .55 m.m.), coated it artificially with manganese, and it worked fairly well even without being aged. I have also used coke with upward flow of water and reduced the iron content to .1 p.p.m. without filtration through sand.

The Burgess Laboratories of Madison have somewhat paralleled the experiments I have made, though perhaps in a more elabrate manner, and as a result have brought out a new material called "Birm" (a coined word, taken from the initials of "Burgess Iron Removal Mineral") for the removal of these elements. This min-

eral has all the advantages of manganese dioxide, but is as light as sand or lighter in weight, and can be backwashed readily. The composition of this mineral has not yet been announced by its makers. However, one might guess that, as this company is a large manufacturer of zeolite and for years have used large quantities of manganese in the manufacture of batteries, it must be some sort of zeolite material coated with manganese.

I used this mineral in a pressure filter for the removal of iron and manganese from the water supply at the Sacred Heart Hospital, Tomahawk, Wis. This water is similar to the Wausau water and would not yield up its iron and manganese by ordinary aeration, sedimentation and filtration through sand, but the plant is giving entire satisfaction.

It has been found that it is necessary to have a small amount of oxygen present when using the catalytic process, and if oxygen is not present in the water, a small quantity will have to be added.

Summary and Conclusions

First of all, bear in mind that all waters containing these troublesome elements are not alike, and while a given process has been known to work well at one plant, it may not at another. It is best to build a small experimental plant under the supervision of one experienced in the treatment of iron-bearing waters before you try out your pet schemes and spend a lot of money on them.

Don't try to use the natural ore as an agent in aerators, as they will in time clog if they perform as they should; nor try to use the finely crushed heavy mineral as you would use sand in a standard filter, for you cannot back-wash it successfully at ordinary wash-water rates.

Although it has not been called a catalytic process, I find from reading of experiences elsewhere that this process, whether intended to be so or not, actually did assist in the final removal of iron and manganese.

If you don't care to use either "Birm" or "Greensand," take such material as anthracite coal and create your own catalysts. I am sure plants can be greatly simplified in their construction and the cost of their operation cut down. I can see no need of making a complicated plant using two or more processes ahead of sand filtration. Either use the ore contact filter with aeration followed by sand, or use the "Birm" or "Greensand" in only one unit for waters requiring such treatment.

The above is a paper, slightly abbreviated, read before the Convention of the American Water Works Association.

Gasoline Taxes Yielded $619,000,000 in 1935

Gasoline consumption by motor vehicles in 1935 increased 6.4 percent over the preceding year and State taxes yielded a revenue of $619,000,000, according to statistics collected by the Bureau of Public Roads of the U. S. Department of Agriculture. Every State reported increased consumption, the largest increase being 13.4 percent in New Mexico. Increases of more than 10 percent are reported for Alabama, Arizona, California, Georgia, Idaho, New Mexico, North Carolina, Oklahoma, Oregon, South Carolina, and Utah.

The average tax rate was 3.8 cents. Gasoline consumed on highways amounted to over 16 billion gallons. This figure includes some non-highway consumption in 13 States that do not allow refunds of the tax for non-highway use. During the year the tax rate was increased by one cent in Connecticut, Delaware, Nebraska, New York, and Pennsylvania.

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Don't forget the READERS' SERVICE DEPT.—pages 55-57.

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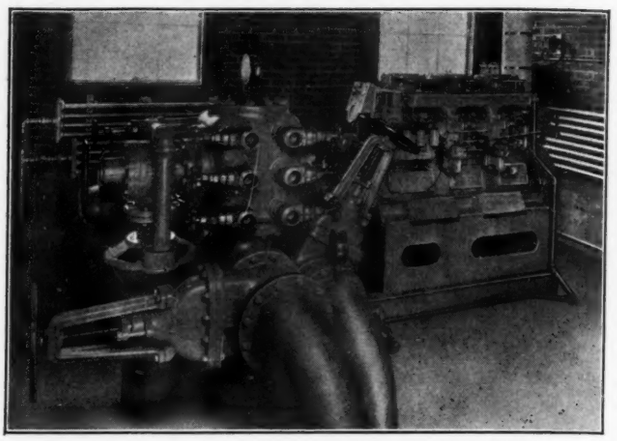

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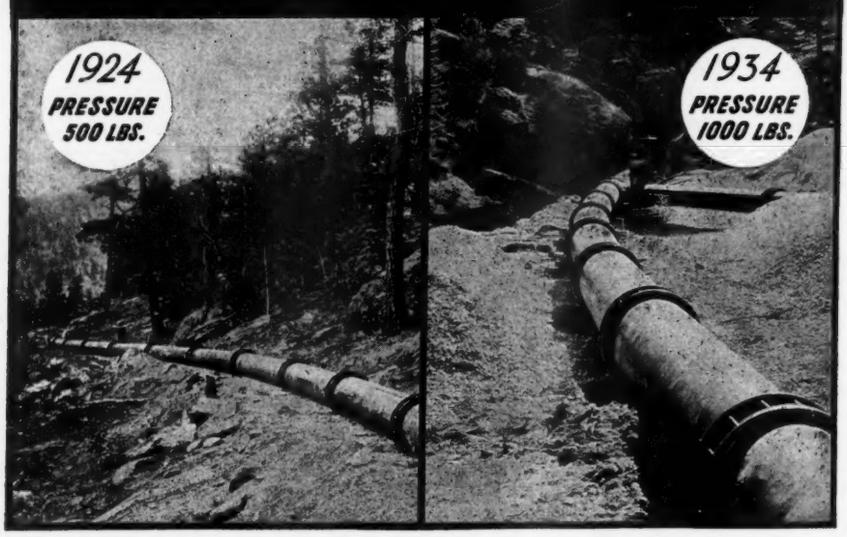

Note: The two views, above, are also good illustrations of Dresser flexibility for making curves with straight pipe.

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When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 55-57.

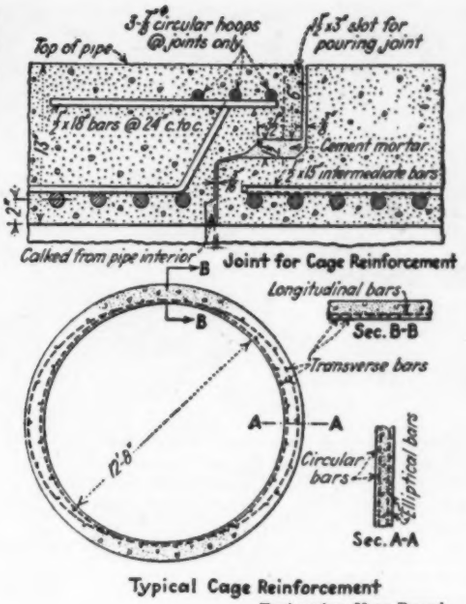
Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

Dam failure was caused by raising spillway level from 5 ft. below top of earth dam to 2½ ft. below, at Elk City, Okla., May 1st. It was 850′ long, 30′ maximum height, 16′ top width, with concrete corewall from 30′ below original ground level. Water slope 3:1 paved with 4″ of reinforced concrete; down stream slope 2:1 sodded. The spillway is V-shaped, built largely on rock, 312 ft. long, with an original capacity of 10,000 sec. ft., which was reduced to 4,400 by building a wall on the spillway with a view to increasing the capacity of the reservoir and without consulting the designing engineer. The rainfall preceding the overtopping of the dam was 3.5 in. in 45 min. and 5.75 in. in 1 hr. 45 min.—the maximum to be expected in that section. At 50% run-off, the maximum flow would be 21,500 sec. ft. It is estimated that the run-off was at the rate of about 680 sec. ft. per sq. mi. of drainage area. The amount reaching a reservoir at Clinton, Okla., during the same storm exceeded 580 sec. ft. by a considerable amount (represented by an 8″ flow over the spillway) and was probably as much as 680. The Elk City dam had been topped last June but nothing was done about it.[E25]

Submarine pipe 54″ diameter in two lines each 2600 ft. long have been laid beneath the southerly end of San Francisco Bay in water averaging 50 ft. deep with a maximum of 70 ft. The pipe was made of ¾ in. steel in 30 ft. lengths, welded, four lengths welded together, and a heavy steel flange welded onto each end of the 120-ft. section. The pipes rested on cradles supported by piles and were bolted together by divers, a 1 x 1″ lead gasket between the flanges being deformed to fill grooves in the joint and allow for slight irregularities of alignment. The pipe was given an internal sprayed priming coat and a centrifugally applied coal-tar enamel coat; and on the outside enamel brushed on over a primer coat and covered by 6 in. of concrete reinforced with a layer of welded wire cloth and vibrated. While the concrete was being applied and for 72 hrs. after, the pipe was kept under a hydrostatic pressure of 200 lb. The pipe was set in a trench dug 4 ft. below the bottom grade of the pipe to permit the divers to work under it. The piles were driven with long extension leads and an underwater air hammer and cut off with an air-driven saw. Only a few piles were more than 6″ out of line. When finally tested under 200 lb. hydraulic pressure, each of the two lines was found to be tight, although the contract permitted a leakage of 676 gpd.[E24]

Concrete pipe of record size, being laid as a part of the Colorado river aqueduct, has several novel features. There is 9.6 mi. of pipe 12′8″ diameter, maximum head 80′. Sixteen 12′ sections a day are cast in a central plant, using 325 cu. yd. of concrete and 40 tons of reinforcing steel. Each section is reinforced with an inner circular cage of steel and an outer elliptical one, wound spirally and welded to longitudinal rods; the total area of steel per sq. ft. varying from 1.8 to 2.8 sq. in., about two-thirds in the elliptical cage. The concrete is mixed in a 4 cu. yd. mixer, all materials except water moving by gravity into weighing devices controlled by electric eyes. It contains 6¾ sacks of cement per cu. yd. and has a slump of 4 to 5 in. While the forms are being filled they are vibrated lightly by external vibrators, and finishing rods (14 ft. of ½ in. sq. reinforcing steel) are put down inside the forms for the full depth of the section and rotated along the inner and outer faces of the section. For the first 5 to 8 hrs. after pouring, wet steam is used to raise the temperature of the concrete to obtain early strength. Forms are removed 12 to 16 hrs. after pouring, the section covered and the interior walls sprayed with water for the two weeks curing period and the outside given two spray coats of cut-back coal tar, which is whitewashed when dry. Pipes are transported to the ditch on low 50-ton trailers attached to diesel trucks. Each joint is made in two operations—the outer part is poured as soon as the pipe is in place; the inner part is made from the inside by pointing mortar into a groove after backfilling has been completed for some time. After laying a cradle is poured with angle of 100° to 180°.[E26]



Typical Cage Reinforcement
Engineering News-Record

Sections and details of Colorado river aqueduct pipe.

Boulder City water, supplying the construction camp for the Boulder Canyon project, is taken from the Colorado river, "the flashiest, most turbulent and heaviest silt laden stream" in the world whose water was being treated for domestic and industrial use. During 34 months of operation the turbidity ranged from 45 to 150,000, total hardness from 94 to 904, non-carbonate hardness from 0 to 691. Variations of over 200 ppm. total hardness have occurred in three hours. Treatment included plain presedimentation, aeration, softening, recarbonization, filtering and disinfection. The general method was plain sedimentation followed by excess lime and soda ash softening with series flocculation, sedimentation and carbonization; but wide fluctuations of raw water caused occasional variations. Generally the most satisfactory method was applying lime and soda ash at the same time as the water entered the first mixing chamber; thorough rapid mixing, then gentle agitation; precipitation in the primary clarifiers; then, in the primary carbonation basin, addition of sufficient CO_2 to convert residual causticity into carbonates; then

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to the second series of mixing basins where activated carbon is added for taste and odor control, precipitation of carbon and carbonates, then addition of sufficient CO_2 to convert all carbonates to bicarbonates with a small excess of free CO_2; then to the filters.

Recirculating sludge from and through the primary clarifier when using low-grade soda ash was fairly successful, but from and through the secondary clarifier was a failure. To aid precipitation in the secondary clarifier during high non-carbonate hardness, alum, chlorinated copperas and ferric chloride proved of little use; activated carbon "aided more in the reduction of the carbonate content than any other agent used and without any loss of its value in controlling taste and odor. When, during the cloudburst season, taste and odor were excessive, 2 to 3 ppm. of activated carbon applied ahead of the secondary clarifier proved very effective. After storage behind the dam began, the water gradually approached uniform conditions and little difficulty was experienced in maintaining a total hardness in the finished product of 90 ppm.[A39]

Meters should be bought on the basis of quality, not price. "Do not buy competition meters. . . . You can be sure of only one thing when using them—the water department always takes the loss. In the larger size service a battery of 2-in. meters gives the best service. We arrived at this conclusion by running them in tandem with large meters, and have yet to find a condition where the battery will not increase your revenue.

"On fire line services, the installation of a detector check will show you that these services are not so inactive as you might think. The detector meter pays dividends in disclosing leaks and stolen water." [A34]

Presumptive test media were compared to determine their relative abilities in the detection of pure cultures of the coli-aerogenes group, their inhibitiveness for aerobic and anaerobic spore-forming rods which ferment lactose, and their efficiencies in water samples as compared with pure cultures. Nine media were studied: 1—Lactose broth. 2—Buffered lactose broth. 3—Brilliant green lactose bile broth 2.0%. 4—Fuchsin lactose broth. 5—Methylene blue-brom-cresol purple broth. 6—Crystal violet lactose broth. 7—Formate ricinoleate broth. 8—MacConkey's peptone lactose bile broth. 9—Trypaflavine broth; No. 8 because of its general acceptance as the presumptive test medium in England and No. 9 because of the favorable acceptance it has received in Germany. The author summarized his findings as follows:

Standard lactose broth was the most sensitive of the nine presumptive test media employed in the detection of *small numbers* of the coli-aerogenes group of bacteria, both in pure culture study and in the determination of the colon group in water samples.

Fuchsin lactose broth was found to be almost as efficient as standard lactose broth as a presumptive test medium. It was practically as efficient as the standard medium in the detection of small numbers of the coli-aerogenes group both in pure culture study as well as in the examination of water samples, and in addition, it markedly inhibited the growth of aerobic and anerobic spore forming organisms which ferment lactose.

Brilliant green lactose bile broth and buffered lactose broth while showing 90% the productivity of standard lactose broth were found to have certain disadvantages and no advantages not possessed by fuchsin lactose. The remaining five media were found to possess a definite inhibitory action for small numbers of the coli-aerogenes group of organisms both in pure culture study and in the examination of water samples.

The calculation of the most probable number values for the three water portions employed showed that fuchsin lactose broth and standard lactose broth gave the highest index values. If it is not possible to develop a medium which will have the same ability to detect coli-aerogenes members as standard lactose without at the same time permitting the growth of certain other organisms which may be responsible for gas formation, the hope expressed by Winslow (1935) for a primary fermentation test which could be accepted as final does not appear imminent.[A37]

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c, indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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May 29

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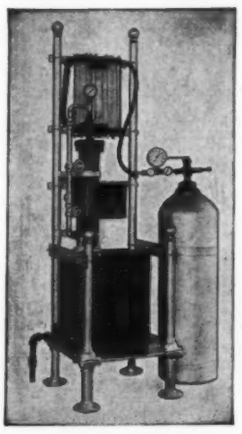
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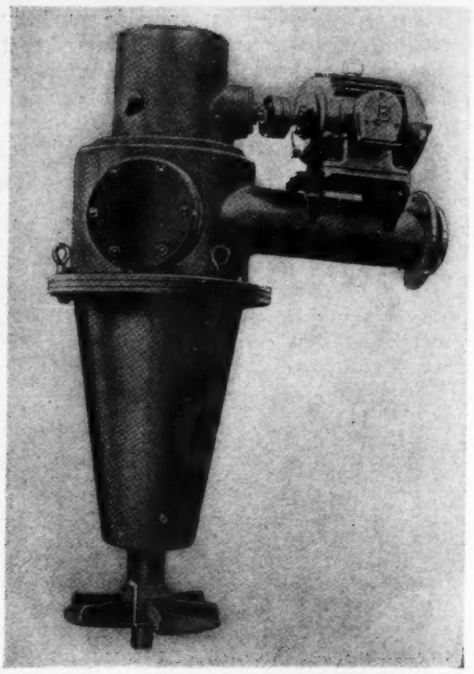
A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

The Digestion Tank

Settling tanks that really settle have been built at Wakefield, England. Four tanks, one 254 ft. by 79 ft. and three 206 ft. by 110 ft. 8½ in. each, were built on an old sludge deposit. Settlement was expected and the tanks were built on a grillage of mass concrete carried down to hard ground. In spite of this, one of the tanks has sunk 2 ft. 3 in. owing to settlement of coal mines below it. "Although at one period the south side of the tank was 4½ in. higher than the north side, it was never necessary to shut down." These are aeration tanks, and agitation and aeration are effected by 68 paddle wheels of framed steelwork, each 10 ft. diameter, which make 15 rpm. Because settlement was anticipated, the shafting was supported on pedestals of the double side adjustable type fitted with plain swivel bearings. The sole plates were slotted for side adjustment, the couplings were of the universal self-adjusting type, and large flexible couplings of the pin and buffer type were provided to protect the gears against uneven settlement.[D20]

Chlorinated copperas has been adopted as the precipitant for London's sewage, being made and applied at southern outfall, Crossness, and at the northern, Beckton. In the summer of 1935, when the use of ferric salts was decided on, neither ferric sulphate nor ferric chloride was available in the quantity required and the idea of combining chlorine and ferrous sulphate was adopted from United States practice. At Beckton the ferrous sulphate in acid solution was at first delivered in tank wagons, but later it was purchased in crystal form as this was found cheaper. Two chlorinators are used, of the injector type, 150 lb. per hr. capacity. The chlorine is delivered in tank wagons, and "an evaporator is used to produce gas at the rate required. This consists of a coil of copper tubing in a cylinder containing hot water. The coil is connected to the tank wagons and to the chlorine main, and electric immersion heaters, thermostatically controlled, are fitted to the cylinder." The mixture of chlorine and ferric liquor is discharged through rubber hose into the five outlet sewers somewhat above the invert; mixing being effected by blowing compressed air through perforated pipes fixed just above the sewer invert immediately below the point of application. The supply of chemicals varies with the rate of sewage flow. The Crossness plant at first differed in some details from the Beckton one, but the two now are essentially alike.[D25]

Sewage farming still is practiced in England. The sewage of 304,500 inhabitants of Nottingham, mixed with about 7 mgd of trade wastes from bleach and dye works is "distributed over the land without any preliminary treatment and is purified by percolating downward through the soil into underdrains, whence it is delivered by means of main effluent outfalls into the river. The sludge is retained on the surface of the soil and after drying is finally ploughed into the land." However, with the increase in volume of the sewage "it has become necessary to provide some means of preliminary treatment of the crude sewage before applying it to the land."[D21]



Sewage Works Journal

German "sludge slinger"

Sludge slingers for digestion tanks have been introduced in Germany, by which sludge entering a tank is distributed over its entire surface, tried at the Nurmberg-Nord plant since Oct. 1, 1935. The entering sewage falls onto a ribbed plate revolving rapidly at the bottom of a vertical shaft, which is driven by a motor supported in the center of the top of the tank, which is 11 meters in diameter. Fresh sludge is introduced at the rate of 140 cbm. per hour for about 2 hrs. a day, 3 kw of current driving the slinger. Instead of the heavy scum layer that formerly formed when sludge was introduced at one point rapidly, a top layer of temporarily floating solids 50 to 70 cm thick is formed. A pair of experimental tanks, one with and the other without a slinger, were operated for about a year and seemed to demonstrate that with the slinger there was 9 to 11% more gas production, absence of thick scum and foaming (in Aug. 5th, after 10 months' operation there was no scum whatever), better digested sludge; and it had a capacity in excess of 0.43 cu. ft. per capita.[C26]

Bio-filtration is a term applied to a process of passing sewage repeatedly through a cycle of trickling filter, detention tank, trickling filter, etc. It appears from experiment that the filter can be operated to advantage at rates as high as 5,000 gpd. per cubic yard of filter medium (which may be only 3 ft. thick), and "the purifying capacity per cubic yard of rock varies directly with the rate of sewage application to the filter bed." It is probably desirable to pass the sewage first through a sedimentation tank. The sewage is circulated between tank and filter by means of a pump. If this pump at five times the rate of sewage flow, and the filter operate at 5,000 gpd., the latter would still be only about ¼ the volume ordinarily provided. The process is considered to combine the functions of a trickling filter and activated sludge treatment and "it appears possible to combine in a single form of treatment the major advantages of the activated sludge process and of the trickling filter (bacteria bed), and at the same time to obviate the more serious shortcomings of either

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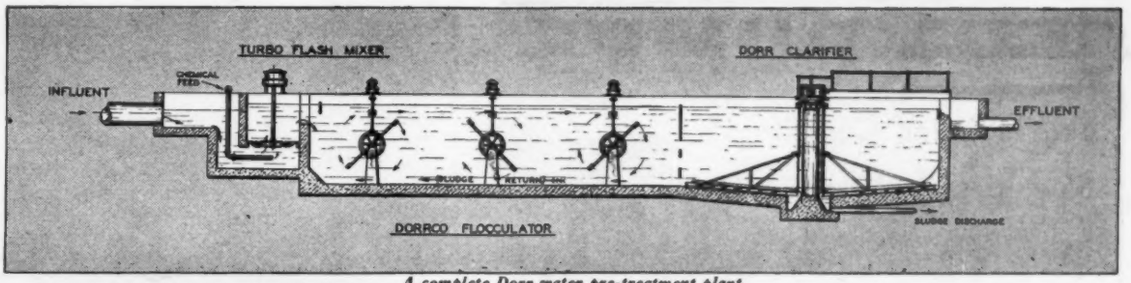

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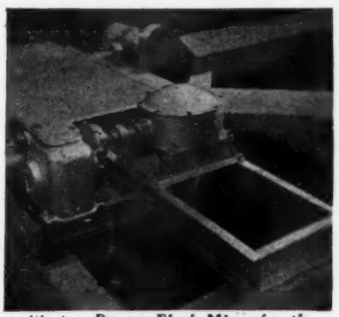

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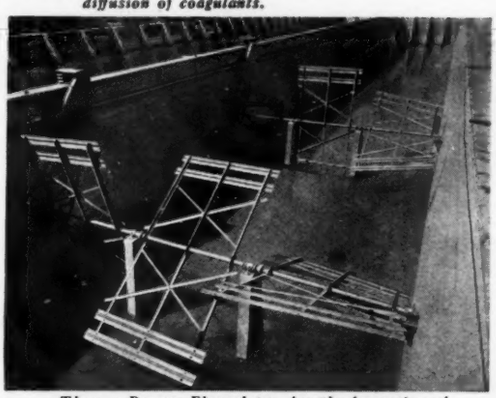

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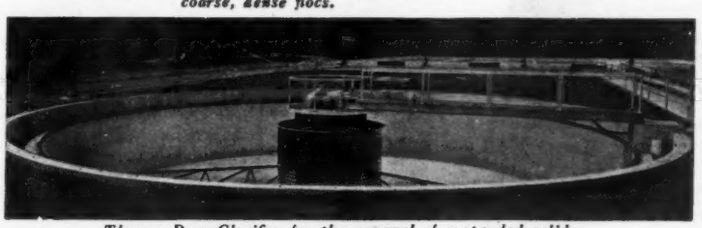

Then, a Dorr Clarifier for the removal of suspended solids.

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Installed cost $11,000
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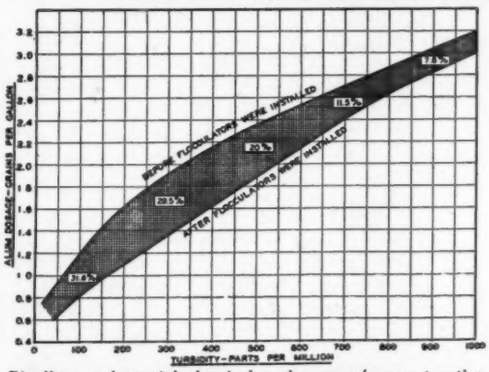

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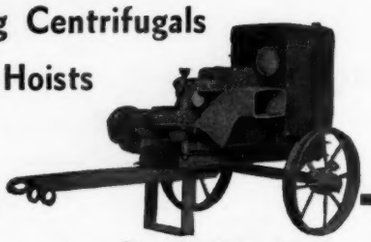

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method." "Other conditions being equal, a sewage requiring 6 hours' aeration with activated sludge will generally require 6 hours' recirculation through a system of bio-filters to produce a final effluent of comparable physical and biochemical characteristics." Bio-filtration "compares favorably with the trickling filter in point of first cost, and with the activated sludge process as regards cost of operation," placing it on a par with chemical precipitation.[C14-E8]

Elutriation reduces the amount of coagulant needed roughly proportional to the quantity of soluble decomposition products removed from the liquid surrounding the sludge solids. To reduce the cost of elutriation and give further economies in coagulants, investigations have been made in (1) more efficient washing methods, (2) use of cheaper coagulants, and (3) shortening of digestion time. (1) is obtained by "counter-current elutriation," in which the water in the last of several successive washings is re-used for the first washing of a following amount of sludge. Several washings with a small amount of water will give better results than one washing with several times that amount. It was found that three successive washes using two volumes of total wash water (twice the volume of the sludge) removed 93.33% of the impurities, and one washing in ten volumes of water removed 90.9%. In multiple washing, the final wash waters contain so little dissolved impurity that they can readily be used again for washing. "The use of two small tanks with a maximum ratio of three volumes of elutriating water to one of wet sludge will produce results equal to or better than can be obtained by single-stage washing when using ten volumes of elutriating water." This requires about 30 to 35 sq. ft. of tank area for every ton of dry solids present in the sludge, when operating 24 hrs. daily, and the tanks should provide for about a 4-hr. detention period, or 3-hr. if the sludge is from continuously operated heated digestion tanks, or is raw. On this basis, two counter-current tanks each 25 ft. diameter and 12 ft. deep will wash 10 tons of dry digested sludge solids, i.e. about 6,300 cu. ft. of wet sludge at 5% solids during 24 hrs. of continuous service and when using 18,900 cu. ft. of elutriating water; and save over 80% of the ferric chloride necessary for efficiently coagulating the unelutriated sludge. Also, aluminum sulphate can be used effectively as a coagulant on elutriated digested sludges from Dorr digesters, answering (2). If ferric chloride prices are relatively high in any particular locality, aluminum sulphate can be substituted. As to (3); elutriation appears to wash out more detrimental soluble compounds if applied to sludge when it reaches the period of maximum gas production, and carrying digestion in properly operated heated digestion tanks beyond 20 days will become obsolete practice in plants using elutriation and modern mechanical dewatering devices.[H14]

Channel crossing with the wood stave sewer was decided on by Seattle for the 1250′ crossing of Salmon Bay, partly because the bottom is soft and uncertain and may shift slightly, and because of long life of permanently submerged wood. It was made in two parallel lines of 36″ pipe, tied together by shackle rods; constructed as a continuous pipe on the north shore and slid into the water gradually, and lowered into a trench 13′ wide and 10′ deep; then covered with 5′ of pit-run gravel to protect it from marine borers and dragging anchors. Staves 2½″ thick. First 225′ built on a curve of 600′ radius to fit the high south bank, and last few hundred feet on a slight curve to fit the north bank. Pipe was weighted with concrete blocks to just sink it

into the trench, and pushed (not pulled) across. Greatest difficulty was in keeping the two lines of pipe of exactly the right negative buoyancy. The covering was completed in 60 days at a cost of $39,808.[E3]

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c, indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

C — *Sewage Works Journal*

May

14. *t.* Experimental Studies of Bio-Filtration. By H. N. Jenks, pp. 401-414.
15. *t.* Oxygen Tension and Bacterial Numbers. By H. Heukelekian, pp. 415-421.
16. *t.* Chemical Coagulation of Sewage. By W. Rudolfs and H. W. Gehm, pp. 422-429.
17. *t.* The "Log Difference" Method of Estimating the Constants of the First Stage B.O.D. Curve. By G. M. Fair, pp. 430-434.
18. *t.* Influence of Substrate on Biochemical Oxygen Demand. By W. L. Lea and M. S. Nichols, pp. 435-447
19. Cedar Rapids Sewage Treatment Plant. By J. C. McIntyre, pp. 448-455.
20. Cost Records for Maintenance and Operation of the Worcester, Mass., Sewer System and Treatment Plant. By J. H. Brooks, Jr., and R. S. Lanphear, pp. 456-464.
21. Cost of Operation of the Sanitary District of Decatur. By W. D. Hatfield, pp. 465-474.
22. Chemical Precipitation to Meet Dilution Demands. By C. K. Calvert, pp. 475-484.
23. Diffuser Plate Studies. Discussion of A. J. Beck's paper. By H. E. Howland, pp. 485-488.
24. Progress in Milk Waste Disposal. By C. R. Roberts, pp. 489-498.
25. Use and Abuse of the B.O.D. Test. By F. W. Mohlman, pp. 499-500.
26. A German Sludge Slinger. By B. W. Muller, pp. 514-518.

D — *The Surveyor*

May 8

20. Sewage Disposal at Wakefield, pp. 639-640.
21. Nottingham Main Drainage Works. By R. C. Aldous, pp. 641-642.
22. Norwich Main Drainage. pp. 649-650.

May 15

23. Storage Capacity in Sewer Design. pp. 667.

May 22

24. Discharge of Sewage into Tidal Waters. By W. A. McCartney, p. 703.

June 5

25. Notes on the Manufacture of Ferric Salts for Treatment of London Sewage. By W. P. Warlow, pp. 771-773.

June 12

26. Discharge of Crude Sewage into Tidal Waters. pp. 797-798.

E — *Engineering News-Record*

May 21

8. Bio-Filtration of Sewage. By H. N. Jenks, pp. 721-725.
9. *n.* Sewage Treatment Plant Furnishes Power. p. 727.
10. Current Notes on Sewage Disposal. By W. Rudolfs, p. 739.

June 4

11. Die Cast Asphalt Pipe Joints. By G. E. Hubbell, p. 815.

June 11

12. Flush Wave Velocities in Sewers. By E. W. Lane and O. J. Baldwin, pp. 848-849.

G — *Water Works and Sewerage*

May

9. Effect of Ground Garbage on Sewage Treatment Plant Operation. By C. K. Calvert and S. L. Tolman, pp. 161-168.
10. *p.* Chemical Precipitation Sewage Treatment Plant at Kahoka, Mo. By F. Beard, pp. 169-172.
11. Operating Kinks in Sewerage Practice. By A. M. Rawn, pp. 173-175.
12. Secondary Elements for Water and Sewerage Meters. By L. D. Carlyon, pp. 176-180.

H — *Municipal Sanitation*

June

14. Developments in Counter-Current Elutriation of Sludge. By A. L. Genter, pp. 196-201.
15. Use of Aluminum in Sewage Treatment Works. By R. T. Griebling, pp 202-203.
16. Status of Sewage and Industrial Wastes Disposal in the U. S. By E. D. Rich, R. R. Stewart and C. E. Green, pp. 204-206.
17. New England Sewage Works Men Take Stock of Flood Damage, pp. 207-210.

J — *American City*

1. Sewage Treatment at Sioux Falls. By J. B. Estabrook, pp. 83-84.

L — *Civil Engineering*

June

2. Treatment and Recovery of Sulfite Waste. By F. Merryfield, pp. 374-376.

M — *Canadian Engineer*

1. Progress on the Construction of Greater Winnipeg Sanitary District Works. By D. L. McLean, pp. 3-6, 12.
2. Development of Sulphur Compounds for Jointing Materials. By C. R. Payne, pp. 7-9.
3. Developments in the Chemical Treatment of Sewage. By A. M. Buswell and J. G. Burtle, pp. 10-12.

P — *Public Works*

June

15. A Million-Dollar Storm Sewer Project by WPA. By R. A. Orput, pp. 24-25.
16. Improving Open Stream Conditions in Atchison. By A. W. Seng, pp. 26, 28.
17. *n.* Operating Data of a Sewage Treatment Plant. p. 28.
18. Operation of Dayton Sewage Screenings Incinerator. By M. W. Tatlock, pp. 36-37.
19. *n.* Proteus Process of Sludge Disposal. p. 50.
20. Survival of B. Typhosus in Surface Waters and Sewage. p. 48.

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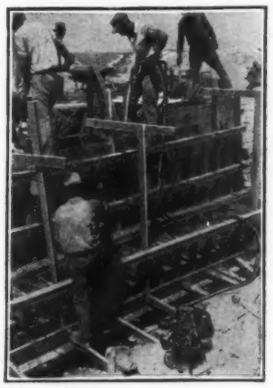
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Here are three Cletrac-drawn, 12-yard hydraulic Austin-Western scrapers. These outfits moved the dirt for the Knoxville airport.

Knoxville's New Airport

THE new airport on Blount Mountain near Knoxville, Tennessee, calls for the leveling of 350 acres of ground and the relocating of approximately one million yards of dirt. In addition to the grading work to be done, the project includes a 120 by 125-foot hangar, an administration building, a radio station of structural steel and brick, and a complete system of storm and sanitary sewers. The total cost of the work will be approximately $500,000.

The field is situated nine miles outside of Knoxville and will give this city, as well as the neighboring cities of Alcoa and Maryville, a first class airport for regular mail, freight and passenger service on American, Transcontinental, and Western Airline routes. Located in the Great Smoky Mountains, it will undoubtedly be one of the most beautiful airports in the country when completed.

The three cities have combined with Blount County to finance the purchase of the 350 acres required and will be joint owners of the property upon its completion. The construction cost is being financed by money supplied by the Works Progress Administration, which is employing local relief labor for the entire project.

In determining the location of the airport serious consideration had to be given to the hazard of nearby mountains to airplanes in landing and taking off. The two Knoxville airports already in operation had both proved dangerous, either because of their location or inadequate size, and it was necessary to make a thorough survey of twelve possible locations before the land could be purchased and the work begun.

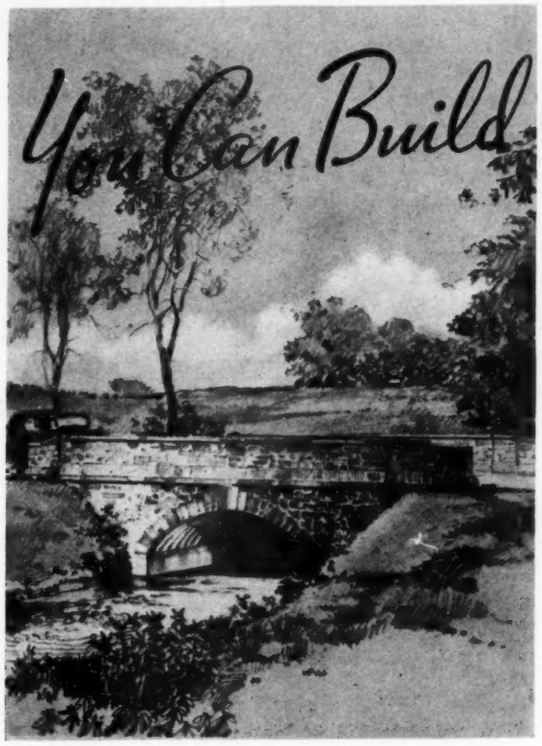
Robert L. Winstead, Knoxville City Engineer, completed this work in 1935. At the conclusion of the survey and after the subsequent purchase of the property he was put in charge of the work as field engineer for all three cities. Ted Prater, of the Tennessee State Highway Department, is superintendent for the 450 men who will be at work on this job, while the entire project is under the jurisdiction of R. L. Morrison, the Knoxille District WPA Deputy Administrator and associate member of the A.S.C.E.

The first task was the removal of all trees and brush from the site and the demolition of several small buildings. This was completed by hand labor from the local relief rolls.

A temporary gravel road from the main highway was constructed for the transportation of equipment and materials on the job, the aggregate being shipped in by truck from the state quarry.

The next step consisted of surveying the entire area, laying out property lines, the location of trenches for fifteen miles of

On rolling terrain, such as shown in the illustration, left, the scrapers dig in both directions and dump their loads on either side of the high ground.



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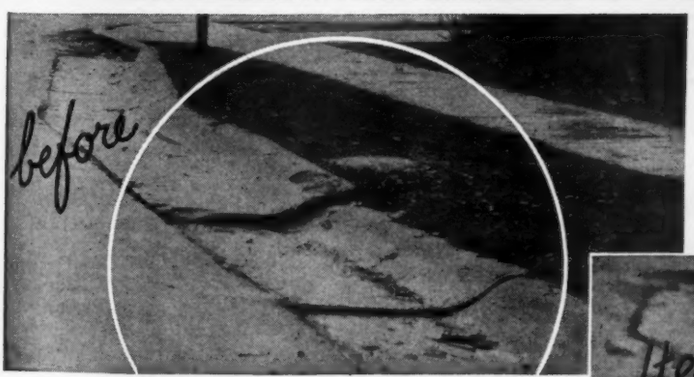

Sunken Curb and Gutter Marked for Reconstruction

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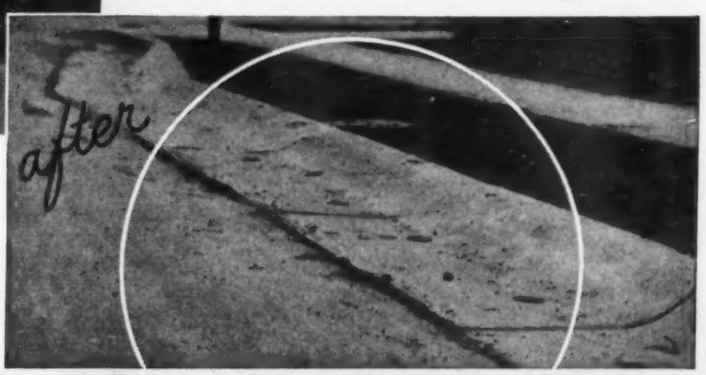
THE MUD-JACK METHOD *corrected the settlement and saved the reconstruction costs*



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tile storm drains beneath the landing field, and the laying of a 6-inch water main from Alcoa, a distance of 6,280 feet.

With the completion of the survey, three 12-yard Austin-Western scrapers hauled by Cletrac "80" tractors were put into operation to remove knolls and ridges and bring the low spots up to grade. The scrapers and tractors, operated in tandem, make their cut and carry to the fill. On the return trip they cut and carry in the opposite direction, discharging the load in a second fill, thus eliminating the necessity for dead heading over the cut in order to get into position. The maximum cut is 16 feet and this is being handled by a 1½-yard shovel loading into trucks.

In addition to the grading operations, these machines will also be used to construct the subgrade for the runways. Because the prevailing winds run north and south the longest runway, 4,965 feet, will be placed in this position. Other runways of the same 150-foot width but having a length of 3,592 feet and 3,340 feet, will permit landing and taking off in any direction. The concrete used will be 8:6:9 thick, with a 1:2:4 mix.

Stone from the state quarries will be furnished for all concrete work, while cement, sand and gravel will be trucked in from Knoxville.

During the laying of the tile and the construction of the runways it is estimated that approximately 600 men will be employed directly on this project, and in order to provide adequate transportation the Louisville and Nashville railroad will run a shuttle train from Knoxville on a spur line which lies close to the airport. At present, however, labor transport for 300 men, working eight hour shifts, is by truck and automobile. When the job is going at full speed the present sixteen-hour day will be stepped up to twenty-four hours per day and it is estimated that with this twenty-four hour schedule the scrapers will move about 11,000 yards of earth in that period of time.

With the drainage system in and the runways completed the field will be turfed.

Upon the completion of the project, about November 1st, the airport may be used as the new southeastern headquarters for the United States Army Air Corps. For this purpose it is ideally situated, since it is about four hundred miles from the coast at a strategic position, with the barrier of the Great Smoky Mountains as an additional protection. Space for an additional hangar has been allotted and this structure will be built when increased traffic requires it.

Transplanting Roadside Trees in California

California has long given close attention to conservation of trees bordering state highways. Recently, in connection with realignment work along a highway between Corning and Red Bluff, an attempt was made to transplant trees. These had been planted some twelve years ago; they were mostly oak, black walnut, ash and plane trees. The work was reported by E. S. Whitaker, assistant arboriculturalist, as follows:

"Work was begun on March 18 under the direct supervision of Maintenance Superintendent E. L. Stump, and was carried out in a manner that allowed the entire job to be accomplished at a cost of $15 per tree.

"Due to the advanced season and the type of soil, in which water available to plants was rapidly reaching the wilting point, it was necessary first to soak the tree basins so that as many roots as possible could be saved. A three-quarter-yard power shovel then dug around each tree, leaving a ball approximately 4 feet in diameter.

"Roots within this ball were carefully combed free of as much soil as possible and the tree was lifted free of the soil by means of a beam fastened in a dump truck, the bed of which was raised and lowered as desired to use the beam as a hoisting lever.

"With roots well covered with wet burlap, the tree was transported to a previously prepared hole and replanted. In this last operation, roots were pruned, good top soil was placed around the roots, and the tree was well watered in to insure against air pockets in the soil.

"The tree crowns were also heavily thinned out, but not topped; in this way leaving terminal growth, while removing a portion of the crown growth to compensate for the loss of root area. In their new locations, the trees were basined around and mulched with straw, and they will be watered once each week during the dry season.

"New leaves have already been forced out, the oaks and walnuts responding equally to the treatment. It remains to be seen, however, whether this is a last effort towards reproduction by a dying tree or the definite continuance of retracted spring growth.

"However, the work, even if only 80 per cent successful, will be considered well worth the cost and will be conducive to further efforts in this type of conservation under similar conditions in the future."

A Year's Sludge Incineration at Dearborn

Incineration in the new Nichols Herreshoff incinerator of sludge dewatered on vacuum filters at Dearborn, Mich., began March 1st, 1935, and the record of a year's operation is now made public. The incinerator and the plant in general have already been described in *Public Works*.

The sludge pumped to the West Side plant during the year totaled 22,265,400 gal. with an average solids content of 4.18%, the monthly averages varying from 0.96 to 7.0. The West Side plant itself produced 7,733,370 gal. of plain and chemically precipitated sludges with an average solids content of 10.1%, the monthly averages varying from 7.8 to 13.2%.

The dewatered sludge passed on to the incinerator totaled 12,015.6 tons with an average solids content of 33.35%, the monthly averages varying from 28.8% to 37.5%. The average volatile content of the sludge was 48.8%, and the average Btu per pound was 10,485, the monthly averages ranging from 9,250 in September to 11,340 in May.

The incinerator operated 5,512 hrs. or 62.75% of the time, using 25,162 gal. of fuel oil, being 2.09 per ton of filter cake or 6.13 per ton of dry solids; and 48,788 kwh. of power, averaging 4.06 per ton of filter cake or 11.90 per ton of dry solids.

One man per shift easily took care of all duties involved in sludge conditioning, dewatering and incineration, and labor cost of incineration was based on using one-half of his time.

On the basis of the above, the cost per ton of filter cake averaged 17.1 cts. for labor, 8.4 cts. for fuel, 4.1 cts. for power and 3.4 cts. for maintenance and supplies; a total operating cost of 33 cts. Fixed costs are figured at 27 cts., giving the total cost 60 cts. per ton of filter cake or $1.76 per ton of dry solids.

The cost of conditioning and dewatering was 81 cts. per ton of cake, or 97 cts. including fixed charges; giving the total of sludge disposal as $1.57 per ton of filter cake, or $4.62 per ton of dry solids. If the time the furnace was idle be included, the costs become $1.69 and $4.97 respectively.

Among the exhibits at the American Water Works Association Convention: Left, Industrial Chemical Sales Co., New York. Center, The Chicago Bridge and Iron Works. Right, the exhibit of the Pittsburgh Des Moines Steel Co.

American Water Works Association

The 56th annual convention of the American Water Works Association was held at Los Angeles, Calif., June 8 to 12. The attendance was about 1000, with a registration of somewhat less than this. Considered from all angles, this was one of the most successful conventions held in recent years. Attendance was exceptionally good among water works officials from the west.

Many of the members from east came by special train, some 85 starting from New York and others being picked up along the way. This train stopped at many points of interest en route, giving the travelers opportunity to see the points of interest along the way.

The New Officers

W. W. Hurlbut, engineer of water works, Los Angeles, Calif., was elected president, succeeding Frank A. Barbour, hydraulic and sanitary engineer, Boston. William W. Brush of New York was reelected treasurer. New chairmen of division were appointed as follows: C. J. Lauter, Washington, D. C., water purification; W. Victor Weir, St. Louis, Mo., plant management; Hal. F. Smith, Detroit, finance and accounting.

Committee Reports

Reports of committees began Monday morning, some fourteen of them presenting more or less complete reports. Leonard P. Wood of New York reported on steel water pipe, stating that specifications for the various types of steel pipe were being prepared, as well as specifications for coatings for such pipe. Louis R. Howson of Chicago reported on steel standpipes and elevated tanks, outlining the changes in the specifications as presented at the Cincinnati convention last year. Thomas H. Wiggin, reporting for the committee on cast iron pipe, said that plans were under way for issuing a manual covering the design of such pipe with reference to necessary thickness to meet all conditions. He also reported on tests made under the direction of the committee, stating that these tests have been completed on both pipe and fittings for 12-inch size and smaller, but that the work on the larger sizes is not yet finished.

The importance of proper instructions and training for water works operators has been widely recognized, according to the report of Prof. L. V. Carpenter of the New York University, who stated that all but nine states now have short schools or other courses for operators.

Plant Management and Operation

There were two sessions of this section—Monday afternoon and Thursday afternoon. The first paper, by H. A. Harris, Jr., of the California Water Service Co., brought out the fact that this company had 140 pumping stations, of which 104 are automatically and 36 manually controlled; but of this 36, 20 are standby or peak load plants. Three general types of automatic control are used: float switch; pressure or hydrostatic control; and time clock. In some cases various combinations of these are used.

L. L. Lewis and L. H. Polderman, both of the Carrier Engineering Corp., discussed the relation between air conditioning and water works, the report being read by Mr. Polderman. Water is used as the principal means of absorbing the surplus heat, though other means are available. If the demand for air conditioning continues to increase at the rate of increase during 1935, within three years the average daily per capita use will be 4 gallons, with a peak of 13 gallons.

Hans V. Pederson, general manager of the Marshalltown, Ia., Water Works, presented an interesting paper on those not served by city water. He showed that, in his city, 361 single houses, with 1400 persons, out of a total population of 18,500 were not served by city water.

The control of chlorination by means of an automatic residual apparatus was described by R. F. Goudey, this equipment being used on the Los Angeles water system. Samples of the water are taken at 3-minute intervals and the chlorine dosage automatically varied to maintain the desired chlorine residual. Samples are taken 300 feet below the point of chlorine application.

An excellent paper was presented by E. W. Breitkreutz of Los Angeles which stressed the value of proper records for a distribution system, and described the methods used at Los Angeles. These consist of a large master map in the office, showing all lines, hydrants, valves, etc., complete print files in each district, and books of small sheets for field use which show all information on pipes, valves, etc.

California Day

Practically all of Tuesday was devoted to papers on California water installations and problems, with descriptions of the Los Angeles and San Francisco supplies, the Colorado aqueduct and waterworks problems and practices in the west. Many of the papers at other sessions also dealt with western water problems.

An excellent booklet describing the Los Angeles supply was distributed, and a topographical model was set up in the registration room. This beautifully executed job brought forth many favorable comments, and excited lots of interest.

Water Purification Division

As usual, the water purification section was well represented and enjoyed a variety of excellent and interesting papers. Those at the Monday afternoon session included a sub-committee report on activated carbon tests and specifications by M. M. Braidech of Cleveland; a paper on methods of testing and significance of boron in water supplies by Ray L. Derby of the Los Angeles Water Department; a similar paper on fluorine and fluorides by Joseph M. Sanchis, also of the Los Angeles Water Department; and a discussion of plankton and insect larvae control in California waters by G. E. Arnold of the San Francisco Water Department.

The next session was devoted principally to iron and manganese removal, with papers by Eskel Nordell of the Permutit Co., N. Y., who discussed removal by zeolitic processes; and by W. G. Kirchoffer of Madison, Wisc., consulting engineer, who considered the use of beds of manganese ore. Prof. Langelier of the University of California discussed the analytical control

The Simplex Valve & Meter Co. had an interesting exhibit.

of anti-corrosion water treatment.

Filtration was the subject at the Tuesday afternoon meeting, with mixing, coagulation, filter design as related to operation, filtration without preliminary coagulation, and maintenance of filter plant equipment being discussed respectively by Carl M. Hoskinson, chief engineer of the filtration plant at Sacramento; Kenneth W. Brown of the California Water Service Co.; Harry N. Jenks, consulting engineer of Berkeley; Joseph De Costa of the Oakland East Bay Municipal District; and John Perhab, superintendent of filtration at Beverly Hills.

General Sessions

The Water Purification Division also had an important hand in one of the main sessions. Frank Hale discussed iron removal without aeration; Marsden Smith of Richmond spoke on recent developments in the preparation of raw water and the use of chlorinated copperas at Richmond. There followed a symposium on developments in water supply practice, with papers by Samuel B. Morris, professor of civil engineering at Stamford, on dams, pipe lines and pumping; by L. H. Enslow of the Chlorine Institute and *Waterworks and Sewerage* on water treatment; by William W. Brush of *Waterworks Engineering* on distribution and service; and a kink and gadget paper by Fred Stuart of New York.

Tuberculation was the main topic of the Wednesday general session, the program starting with a report by E. K. Wilson of the Pitometer Co. presenting the results of more than 900 tests to determine coefficients, his data confirming for the most part the NEWWA tests previously reported. Frank Barbour's paper presented many facts tending to show that pipe line capacity is lost much more rapidly than has generally been assumed, and that enamel and cement linings aid materially in retaining high flow coefficients. Clinton Inglee of the National Water Main Cleaning Co., and Fred Nelson of the Newark, N. J., Water Department, collaborated on a paper describing the cleaning and rehabilitation of a large main. Harry Hayes and L. E. Goit, both of the Los Angeles Water Department, described the protective treatment of steel pipe lines as developed by the Los Angeles Bureau of Water.

Finance and Accounting

Two sessions of this section were held, with papers and discussion by S. W. Zerman of the Hackensack Water Co.; H. F. Smith of the Department of Water Supply of Detroit; E. W. Plowman, formerly of the Denver Water Board; Frank Twohy of Los Angeles; H. L. Meites, superintendent of water, Chicago; and James E. McCaffrey of the California Railroad Commission.

Entertainment

The lighter side of the program was extremely well planned and most enjoyable. Outstanding was the All-Division Dinner; this alone would have made the entertainment program a success. Under the direction—and the painstaking tutelage also—of W. J. Orchard of Wallace & Tiernan Co., this outdid all other previous events. Among the talent were Charles Ramey, Harry Sloat, George Sopp and R. C. Totten of the Los Angeles Water Department; Dud Dudley of the Utilities Supply Co., Los Angeles, Newt Withers of *Western Construction News* and Clint Inglee of the National Water Main Cleaning Co., N. Y.; Leon Chamberlain of the Water Works Supply Co., Mrs. Withers, Walter H. Cates, Western Pipe & Steel Co., A. Lionel Gardner and Nat Young, all of Los Angeles. In addition to some fine singing, a number of excellent and timely parodies and original productions made hits. Some of these we hope to publish in these pages later; they are worth it.

The Maryland-Delaware Water and Sewage Association

The Tenth Annual Conference of The Maryland-Delaware Water and Sewerage Association was held in Frederick, Maryland, on May 14 and 15. There was a registration of 132, with 116 attending the banquet.

After the address of welcome by the Mayor of Frederick, the meeting opened with a Plant Problem Hour. The first speaker in the period was Edward S. Hopkins, Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md., who discussed sand analysis and its relation to wash water rates. Mr. Hop-

Permutit exhibit at the AWWA Convention.

Why CAST IRON is the standard for water mains

The following tabulation shows the percentage of cast iron pipe used in the water distribution systems of the 15 largest cities in the United States as reported in 1935 by their Water Departments.

CITY	PERCENTAGE
New York	97.2
Chicago	100.0
Philadelphia	98.3
Detroit	98.7
Los Angeles	74.0
Cleveland	98.9
St. Louis	98.7
Baltimore	99.7
Boston	99.8
Pittsburgh	97.9
San Francisco	76.8
Milwaukee	100.0
Buffalo	99.8
Washington D.C.	98.8
Minneapolis	95.8

When New York City engineers uncovered this 105-year-old cast iron water main to cut in a new valve, their comment was "that pipe looks good enough to last another hundred years."

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Cast iron is the standard material for water mains the world over. Its useful life is *more than a century* because it effectively resists rust. It is the one ferrous metal pipe for water or gas mains or sewer construction that will not disintegrate from rust. Available in diameters from 1¼ to 84 inches.

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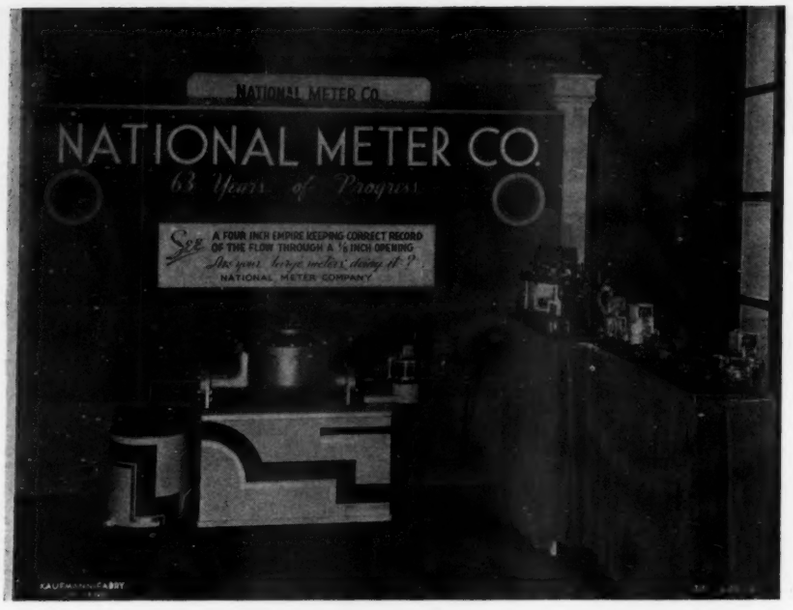
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The exhibit of the National Meter Co. at the AWWA

kins recommended a marked pole, equipped with small pans spaced one inch apart, for checking the expansion of the sand bed during washing. J. M. Jester of the Washington Suburban Sanitary District spoke on Taste and Odor Problems at the Burnt Mills Plant. This plant experienced considerable taste due to snow water in the latter part of February of this year. Every known method for eliminating this difficulty was tried out, but with the exception of a 10 grain per gallon dose of activated carbon little improvement was noted. Reducing the washing period of the bed and seeding the filter with 3 pounds activated carbon per million gallons was suggested. After 2 hours a marked improvement was noted in the filter effluent. There was also a marked improvement in the raw water at this time, making it difficult to determine the value of seeding the filter bed.

G. E. Harrington, Assistant Chief Chemist, Dalecarlia Filtration Plant, Washington, D. C., spoke on The Potomac River Flood of 1936. The flood waters caused a rapid increase in turbidity up to a maximum of 3500 p.p.m. in the outlet of the settling reservoir. High mud concentration absorbed the floc and continued application of alum lowered the pH from 7.3 to 5.0, increased the CO_2 from 3 to 40 p.p.m. and decreased the alkalinity from 30 to 5 p.p.m. The alum dose of 6.9 grains per gallon, the highest in the plant history, was rapidly depleting the supply of chemicals and not properly conditioning the water for filtration. To overcome this condition the load was taken from the Dalecarlia plant and transferred to the McMillan slow sand filtration plant. Prior to reaching the McMillan plant, the inadequately treated water passed through an additional sedimentation period and the filters with a three million gallon per acre per day rate successfully handled the water containing 150 p.p.m. turbidity.

H. E. Rhodes, Superintendent, Sewage Treatment Works, Hagerstown, Maryland, told of some of the problems occurring at the recently constructed activated sludge plant. Difficulties which remain unsolved are sludge bulking in the secondary clarifier, disposal of vacuum filtered sludge and odors about plant during the summer months. James V. Cannen, Chief Chemist at the Hagerstown water treatment plant, closed the plant problem hour with a discussion of long range chlorination. By the addition of ammonia to water obtained from the Potomac River phenolic tastes were overcome and reductions in chlorine dosage were possible, at the same time permitting residual chlorine readings throughout the distribution system. Following the success with this treatment, the ammonia chlorine treatment was applied to Hagerstown's mountain streams and permitted obtaining residual chlorine readings in the city, eight miles from the point of application. With the addition of ammonia the chlorine dosage has been cut almost in half and excellent bacteriological analyses are obtained which was not always possible without the ammonia.

The second major paper was presented by Harry A. Faber, Assistant Sanitary Engineer, Chlorine Institute, who spoke on the Ammonia-Chlorine Treatment as Applied to Water Purification. This paper was discussed by L. Hedgepeth of the Pennsylvania Salt Company.

The afternoon session was opened with a paper, "Are Waterborne Diseases Still a Menace?" by E. S. Tisdale, Director, Division of Sanitary Engineering, West Virginia State Department of Health. Discussing this paper, Dr. C. H. Halliday, Epidemiologist of the Maryland State Department of Health, stated that some of the largest waterborne epidemics have occurred within the last ten years, and the need for constant vigilance is apparent where in 1921 to 1924 five repeat outbreaks occurred. Dr. Halliday in emphasizing the fact that waterborne diseases still are a menace, stated, "Should we let down our present control of water supplies one may predict without fear of successful contradiction that the mortality and morbidity rates from enteric diseases would soon reach the high level of the nineties and early years of the twentieth century."

"The Prevention and Elimination of Potential Cross Connections in Plumbing Installations," was the title of a joint paper by Dr. W. H. Schulze, Director, Bureau of Environmental Hygiene, and Carroll H. Reynolds, Chief Plumbing Inspector, both of the Baltimore City Health Department. The many types of cross connections in plumbing fixtures were discussed and illustrated by lantern slides. J. S. Strohmeyer, Distribution Engineer, Baltimore City Water Department, in discussing this paper stated that over 900 cross connections in Baltimore had been eliminated since 1933.

Earl Devendorf, Associate Director, Division of Sanitation, New York State Department of Health, next presented a paper, "Legal Responsibilities of Water Works Officials, Water Companies, and Municipalities for Waterborne Disease." Mr. Devendorf cited outbreaks and the resultant financial losses at Schenectady, Amsterdam, Albany and Olean. "When it can be proven that disease or death has resulted from the consumption of impure or infected water furnished by a municipality and that the impure water is the result of negligence on the part of the municipality, there seems to be no doubt that the municipality is liable for the same. There have been many decisions of courts throughout the United States which have determined and upheld this principle." George L. Hall, Acting Chief Engineer, Maryland State Department of Health, in discussing the paper gave several references to court decisions and also gave an instance where the local authorities through apparent lack of knowledge of their responsibilities permitted workmen to walk on the ice of the filtered water reservoir to construct a timber bulkhead, and ignoring the recommendations of the State Department of Health to take additional precautions for the safety of the supply, had shut down the chlorinator during these operations. Fortunately, no cases of intestinal disease developed in the town.

The first paper of the second day was presented by Dr. Willem Rudolfs, Chief, Division of Water and Sewage Research, New Jersey Agricultural Experiment Station, on "Trends in Sewage Treatment." This paper was ended with the following conclusions: (1) Modern chemical treatment will be perfected and continue to be one of the important methods of sewage treatment without replacing other methods; (2) physical treatment processes will make great strides, without displacing chemical or biological methods; (3) biological treatment processes will be improved and again come to the front, finding its own place; (4) each method will fit the peculiar needs of the locality. Stimulation and perfection of all three methods is, therefore, desirable and necessary to provide

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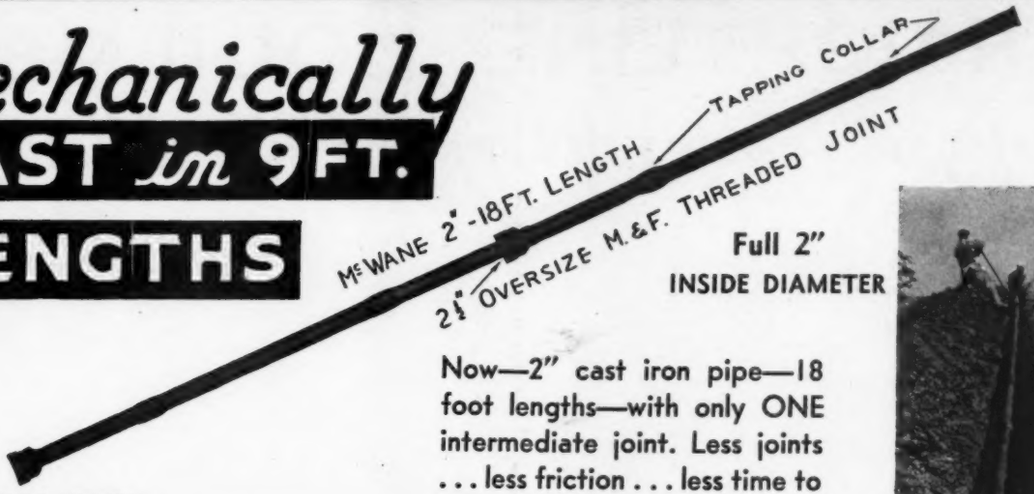

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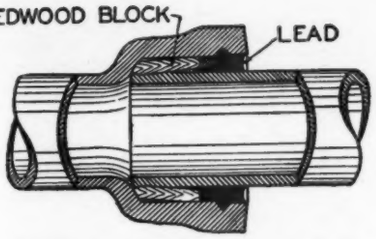

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Here's real news, too! In casting these 9-foot lengths *mechanically* McWane steps up tensile and transverse strengths . . . makes it easy to lay this *permanent* pipe around curves without fittings. Write for folder WG-36!

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greater choice and more possibilities to serve the needs; (5) with this increase in types of treatment, sewage purification and stabilization will increase; (6) future sewage treatment will be, in general, more costly, but lower in cost for equal purification than obtained by present methods; (7) with increased complexity of methods of treatment, operation difficulties will decrease, control will be more exact, and more uniform results will be obtained, and (8) future sewage treatment plants will call for better and more extensively trained operators, but will require less manual labor.

At the business meeting James V. Cannen, Chief Chemist, Hagerstown Water Filtration Plant, was elected President; Edward S. Hopkins, Principal Sanitary Chemist, Baltimore City Water Department, was elected First Vice President, and C. J. Bruce, Superintendent, Evitts Creek Water Company, was elected Second Vice President. A. W. Blohm, Assistant Sanitary Engineer, Maryland State Department of Health, was re-elected Secretary-Treasurer. W. Compton Wills, Chief Engineer, Wilmington, Delaware, Water Department, was elected to the Executive Committee for a 4-year term. The constitution of the Association, was revised to include active members from the District of Columbia, and non-resident membership was provided for engineers and operators outside of the area covered by the Association, namely, Maryland, Delaware and the District of Columbia. Rehobeth Beach, Delaware, was tentatively selected for the 1937 Conference.

Sightseeing trips were provided for the ladies, and the inspection trips were to the Frederick water and sewer projects.

S. & C. I. W. T. P. O. A.

The Southern and Central Illinois Water Treatment Plant Operators' Association held their annual spring meeting May 12 at Staunton. The morning discussion was devoted to "coagulation and turbidity" during which various operators explained their methods of determining the necessary amount of coagulants. It was surprising to note the large number of operators using the jar tests with the laboratory stirring device and some of their testimonials converted the other operators who were determining dosages by the hit and miss method. Chemist J. G. Weart of the State Health Department gave the formal paper on coagulation and turbidity, concluding his talk with the demonstration of the use of the Jackson turbidimeter.

With the introduction of this question many interesting comments and reasons were given for turbidity being found in filtered water. Dr. Kramer, Sr., Chemical Engineer of the St. Louis Water Works, demonstrated the uses of the Baylis turbidimeter.

At the afternoon session, which was devoted to algae, tastes and odors, many interesting algae experiences were related, among these being the troubles at the Central Illinois Public Service plant at Effingham, described by Chemist Holaday. During the past winter at this plant algae started to develop in the clear well and after considerable study its cause has not yet been determined. It is being controlled by feeding copper sulfate to the clear well or mixing basin. After discussing what algae and the various microscopic organisms do, an illustrated lecture by Bacteriologist E. S. Clark of the State Health Department was given, showing some of the common algae, especially those causing tastes and odors in Illinois surface water supplies. The real treat of the day followed with the showing of the film on algae prepared by Major J. Hawley of Ft. Worth, Texas. Various types of micro-organisms were shown in action and this excellent piece of photography proved especially instructive and important.

The officers elected for the coming year are: Chairman, Roy Graves, Chief Operator, Springfield; Secretary, George Stoldt, Superintendent at Jacksonville. The retiring officers were: Chairman, Net Atkinson, Superintendent at Vandalia; Secretary, Clifford Fore, Operator at Carbondale. Total registration for the meeting was 70.

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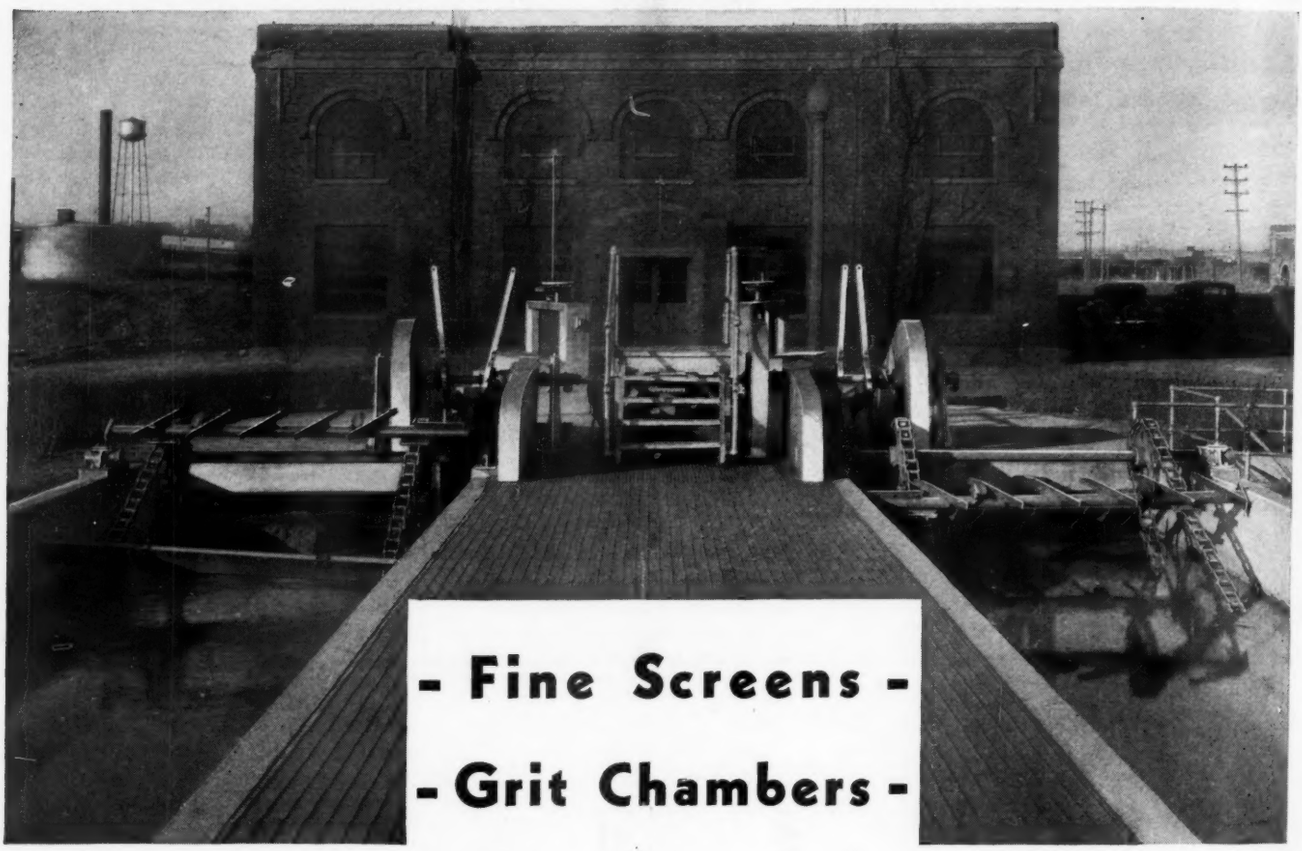

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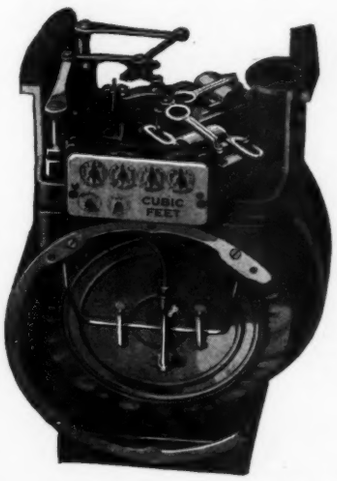
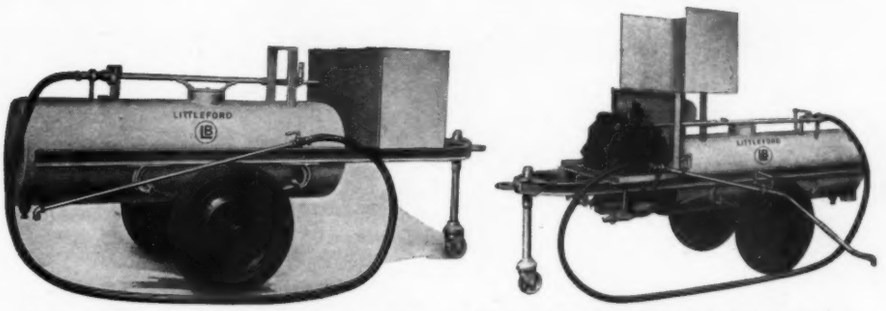
Don't forget the READERS' SERVICE DEPT.—pages 55-57.

News and Illustrations



This meter is especially designed for handling sewage gas. All parts in contact with the gas are plated ware made of special resistant materials, these features being in addition to anti-corrosive precautions already used in these meters. A full description is given in Catalog EG40. Write to American Meter Co., 60 East 42nd St., N. Y., for this.

This is the new 12-yard Carryall Scraper just announced by Le Tourneau, Peoria, Ill. Cable-controlled, with a cutting blade 10 ft. in width. Tires are 18 x 24, reducing draft on tractor and permitting use in soft ground.



THIS SHOWS THE NEW LITTLEFORD EMULSION SPRAYING UNIT

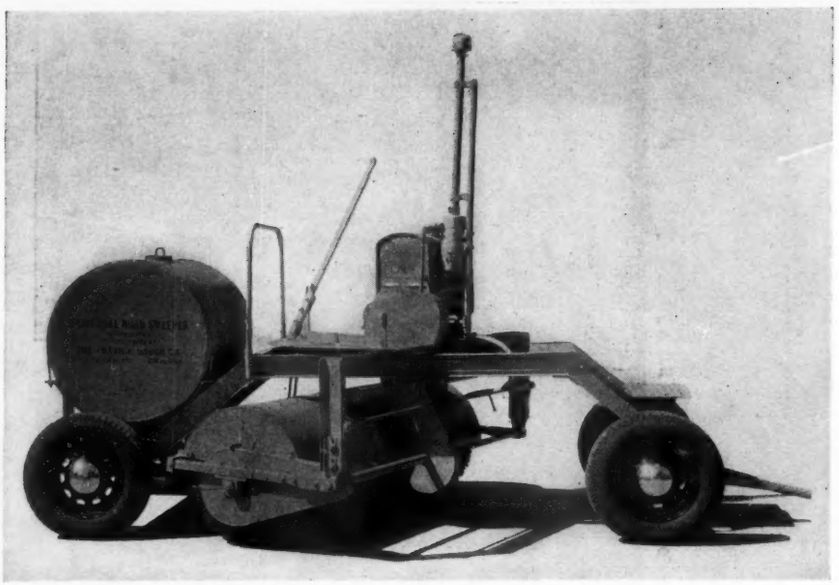
THIS SHOWS THE NEW LITTLEFORD CUT-BACK SPRAYING UNIT

These products of Littleford Bros., Cincinnati, O., differ in that the Model 930B, shown at the right has a heat tube, while the 93AM, shown at the left is for cold applications. Improvements over previous models include a longer tank, better balance, pneumatic tires with disc wheels, and leaf springs.

"The Midget" electric drilling tool of the Chicago Pneumatic Tool Co., N. Y. For 3/16-inch drilling. Looks like and is same size as an automatic pistol. Also made as an electric screw driver and nut runner. Dope on request.

You can build bridges and skyscrapers with these "Superector" wrenches. Made in 5 sizes, 24-inch to 48-inch; hex and square sockets, with hole extending clear through, openings 1 1/16 to 4⅝ inches. Will turn nuts on any length of bolt. Drop-forged handles, quadruple pawls. Write J. H. Williams Co., New York, N. Y. for fuller data.

Officials of The Goodyear Tire & Rubber Company, compare the Double Eagle Airwheel that marked completion of a quarter-billion tires by the company, recently, with an All-Weather Tread tire of 10 years ago. Left to right are R. S. Wilson, vice president and sales manager; President Paul W. Litchfield; L. E. Judd, director of advertising and public relations, and L. H. Shepherd, manager of the Truck Tire Department.



This new low-priced machine, which can be pulled by any small tractor or truck, sweeps to the right or to the left; it is powered by its own engine which operates the brush as well as a rotary gear pump for supplying the water pressure. Its tank holds 200 gallons of water which is sprayed ahead of the brush. The machine will sweep, without raising any appreciable amount of dust, at the rate of five to six miles per hour. Each filling of water is sufficient for from eight to ten miles of sweeping. Write Frank G. Hough Co., Chicago, Ill.

The Dorr Company

With the moving of its main office in New York City from the Park-Lexington Building to the General Electric Building, 570 Lexington Ave., at 51st St., on July 1st, The Dorr Company will complete the transfer of all major functions, including engineering, to the East. Hereafter, the Engineering Department, in charge of design and manufacture, will be permanently located in New York, completing the move from old headquarters in Denver begun several years ago. Research and development will continue to be handled at the Westport Mill, Westport, Conn., as has been the case for the last nineteen years.

The new Dorr executive and sales offices will occupy the entire ninth floor of the General Electric Building, connecting with the Engineering Department and drafting room, occupying half of the floor below. An important feature of the new quarters is to be a large reference library, open to clients and friends, and an exhibit of small scale working models of Dorr equipment, including a replica in miniature of the initial Dorr Classifier invented and developed at Mr. Dorr's gold mill in South Dakota in 1904.

A merger of The LeBlond-Schacht Truck Company and The Ahrens-Fox Fire Engine Company has been ratified by stockholders of the two companies. This brings under one roof two of the oldest automotive concerns in the country—the fire engine company continuing as a branch of the truck company, maintaining the Ahrens-Fox name. The present executive personnel will continue. The LeBlond-Schacht Company was founded by G. A. Schacht in 1913 as the G. A. Schacht Motor Truck Company. The name was changed in 1927. The present Ahrens-Fox Company was incorporated in 1905.

Personals

Major Victor J. Brown, formerly on the staff of Roads and Streets, and for the past three years or so on CCC work, has rejoined the Gillette Publishing Co. as publishing director of Roads and Streets, which publication is to be congratulated. PUBLIC WORKS heartily welcomes Major Brown back into the field of technical journalism.

Francis E. Daniels, chief of the Industrial Wastes Division, Pennsylvania Department of Health, has been promoted to the grade of Lt.-Col., Sn.-Res., U. S. Army. Col. Daniels, who has held the grade of major for a number of years, has been one of the instructors in the class in Military Sanitation, given annually at Carlisle Barracks, Pa.

Carl Lager has been elected president of the Morris Machine Works, manufacturers of pumps, Baldwinsville, N. Y. Mr. Lager joined the organization forty-six years ago as chief engineer, and has been one of the leaders in the development and application of centrifugal pumps. Pierce J. McAuliffe has been elected vice-president and general manager.

Edward S. Hopkins, principal chemist, Baltimore Water Dep't., has been promoted to Captain, Sanitary Corps Reserve.

Stanley B. Stoltz has been appointed temporarily as an assistant sanitary engineer with the Westchester Department of Health. Mr. Stoltz is a recent graduate of M. I. T. in public health engineering.

John H. Huber, former engineer of Bridges and Grade Crossings and Assistant First Deputy Commissioner of Highways, New York State Department of Public Works, is now associated with the Robinson Clay Products Co., New York, N. Y., and Akron, Ohio.

H. Hayden, for many years with Jaeger Machine Co., Columbus, O., is now associated with Edward Ehrbar, Inc., Brooklyn, N. Y., machinery and equipment contractors.

Above is shown the electromatic control at the intersection of Boston Post Road, King's Highway and Old Post Road, at Fairfield, Conn. This automatic control reduced injuries from 20 to 7 in one year. Below is shown a cut-away view of the vehicle detector.

Readers' Service Department

CONTINUED FROM PAGE 56

These booklets are FREE to readers of PUBLIC WORKS.

Couplings for Pipe

386. This sixteen-page booklet is a reprint of a magazine article by a consulting engineer. It describes in detail the installation of a 42" water line; contains specific information regarding pipe joints, field organization, laying pipe, tests, back-filling, etc. Sent free by S. R. Dresser Manufacturing Company, Bradford, Pa.

Fire Hydrants

388. Two new bulletins on M-H fire hydrants and fully bronze mounted gate valves are now ready. Contain full specifications and instructions for ordering, installing, repairing, lengthening and using. Write M. & H. Valve & Fitting Co., Anniston, Ala.

Gate Valves

390. 28 page catalog contains illustrations and complete specifications of M-H standard and extra heavy iron body gate valves, horizontal swing check valves, flanged fittings and flanges, etc. Sent promptly on request by M. & H. Valve & Fittings Co., Anniston, Ala.

Glass Covers

393. Full details regarding the use of Lord & Burnham Glass-Overs at Middletown, N. Y.; Marion, Ohio; Cleveland, Ohio; Freeport, N. Y.; Kitchener, Canada; West Chester, Pa., and other places are given in bulletins 22 to 33. Sent promptly on request to Lord & Burnham Co., Irvington, N. Y.

Laboratory Equipment

400. The Phipps & Bird Stirrer, the solution feeder, a forthcoming stirrer using air for mixing, and all sorts of laboratory equipment for water and sewage plants. Bulletins and folders covering these pieces of equipment are complete and interesting. Phipps & Bird, Inc., 915 East Cary St., Richmond, Va.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

405. "Standard Construction Castings" contains 32 pages of useful data sheets giving specifications and detailed sketches of a wide variety of frames, manhole covers and other castings. Every municipal engineer should have one. Flockhart Foundry Co., 82 Polk St., Newark, N. J.

Pipe, Cast Iron

406. Data on cast iron pipe for water works systems, in sizes from 1¼ to 84 inches, including information on useful life, flow data, dimensions, etc., Thos. F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Concrete

408. Concrete Pipe Sewers, a 28-page booklet, contains much valuable information and numerous illustrations on concrete pipe. Issued by American Concrete Pipe Association, 33 West Grand Ave., Chicago.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints

410. New folder describes in detail a new type of pipe joint—the Dresser Compression Coupling, Style 65, which is compact and self contained, makes a permanently tight joint under all conditions and is installed on plain end pipe in a few seconds with only one tool, a wrench. Get your copy today. S. R. Dresser Mfg. Co., Bradford, Pa.

Pipe Joint Compound

411. A new bulletin has recently been issued giving full details concerning Tegul Mineralead, a quick-sealing, trouble-free compound for bell and spigot joints which permits immediate closing of the trenches. Write The Atlas Mineral Products Co. of Pa., Mertztown, Pa.

Taste and Odor Control

412. How, when and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Co., Inc., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

Pumps and Well Water Systems

413. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps, fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for these three descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office Memphis, Tenn.

Protective Pipe Coating

415. Coal-tar Pitch Enamels for exterior and interior linings for steel water lines; highly resistant to water absorption, soil acids and alkalis. Technical specifications for materials and their application will be sent on request. The Barrett Company, 40 Rector St., New York, N. Y.

Pumping Engines

417. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Rubber Lined Pipes and Pumps

418. New, 68-page catalog describes Ace rubber lined pipe and fittings, hard or soft rubber lined centrifugal pumps and Ace hard rubber double acting pumps, for chemicals used in treating sewage and water and for acids and other corrosive liquids. Contains illustrations and specifications. Issued by American Hard Rubber Co., 11 Mercer St., New York, N. Y.

Runoff & Stream-Flow

420. Technical information on measuring run-off, both from small areas, for storm sewer design, and from large areas for determining water-shed yield, and instruments for measuring. Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

421. The simple, automatic Loughlin, self-cleaning travelling screen is fully described in an interesting bulletin issued by Filtration Equipment Co., 10 East 40th St., New York, N. Y.

423. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 307 No. Michigan Ave., Chicago, Ill. Book 642.

Rainfall Measurement

429. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Bulletin RG and Instruction Booklet. Julien P. Friez & Sons, Baltimore, Md.

Screens

430. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Sludge Bed Glass Covers

432. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Elizabeth, N. J. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Incineration

438. A multiple hearth furnace which meets the most exacting municipal sanitary requirements for the incineration of sewage sludge—produces a fine ash or partially dry sludge for fertilizer—is described and illustrated with drawings and photographs in bulletins issued by Nichols Engineering and Research Corp., 40 Wall St., New York, N. Y. Operation as well as installation data is given.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection, 45 pp., ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Sludge Removal Equipment

442. If you are interested in economical sludge removal, write for the latest bulletin describing and illustrating Louden Monorail equipment which is adapted to open or closed beds. Full details sent promptly by the Louden Machinery Co., 400 West Ave., Fairfield, Iowa.

Swimming Pool Equipment

444. Filters, chlorination, underwater lights and other supplies for swimming pools are very thoroughly described in literature and folders. Plans and layouts. Everson Filter Co., 625 W. Lake St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Treatment

448. New 31-page catalog covers complete conveying, screening and reduction machinery for water purification and sewage treatment; describes and illustrates the design features of Jeffrey self-cleaning bar screen, combined screen and grinder, sewage screenings grinder, grit washer, conveyor type and positive discharge sludge collectors and green garbage grinder—includes installation views. Catalog 615, Jeffrey Manufacturing Co., Columbus, Ohio.

449. Installation views and considerable engineering data including capacity tables for settling tanks and layouts of typical arrangements for both final and primary tanks, are contained in a new booklet—No. 1542—just published for engineers by Link-Belt Company, 307 No. Michigan Ave., Chicago, Ill.

450. Standard Sewage Siphons for small disposal plants and PFT Rotary Distributors are new catalogs recently issued by Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill. The latter catalog contains typical plans and many illustrations of actual installations.

452. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

453. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill., and Philadelphia.

454. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 247 Park Ave., New York, N. Y.

For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Sludge Disposal at Dearborn:

Results of the first year of operation of the Nichols Herreshoff sewage sludge incinerator installed at Dearborn, Mich., are now available in a booklet isssued by Nichols Engrg. & Research Corp., 40 Wall St., N. Y. Operating costs are substantially lower than the average for the test period. Ask for Bulletin 204, which gives the results in detail. Sent on request.

Vacuum Filters for Sewage:

One of those fine and complete mimeographed booklets that give information right up to date. While much of the space is devoted to telling about "Municipal" equipment, there is lots of good dope on sewage treatment. 27 pp.; ill. Sent on request to William Raisch, Municipal Sanitary Service Corp., 155 East 44th St., N. Y.

Concrete Mixes:

A booklet, small in size; only a few pages; but full of dope on proper mixes to use for various kinds of construction; how to determine and secure concrete meeting specifications for cement-content, maximum water permissibility, workability, strength, etc. Gives dope for quick estimating of quantities of material needed. Printed on celluloid to stand rough usage. Sent on request, no charge. Pennsylvania-Dixie Cement Corp., 60 East 42nd St., N. Y.

Spray Nozzles:

A non-clogging spray nozzle for spraying, washing and cleaning all kinds of materials, screens, etc., is described in a folder which gives a description of the nozzle and capacities in gallons of water per minute for the different diameters of orifices at various water pressures. Write Link-Belt Co., 300 West Pershing Road, Chicago, Ill., for copy.

Chlorine Dosages:

Jeff Corydon of "Proportioneers," Providence, R. I., has sent out some mimeographed sheets containing handy data on hypo dosages for water chlorination. Sent on request.

SALES MANAGER WANTED

A company about to engage in the manufacture of an asbestos and cement pipe for water transmission desires the services of a sales manager with the ability and contacts able to put it over as against cast iron pipe. About 10% less cost. Suitable for water pressures 140 to 250 lbs. No corrosion, electrolysis or tuberculation.

State qualifications and compensation.

Address Box 1108, c/o PUBLIC WORKS MAGAZINE, 310 E. 45 St., New York, N. Y.

Sewer Pipe Data:

An Engineers' Manual on Robinson vitrified clay sewer pipe and its uses has been issued by Robinson Clay Products Co., Akron, O., and New York, N. Y. This is an excellent booklet giving data on strength of pipe; formulas for external loads; charts on the same, arranged for ready use; data on methods of laying pipe; data on manholes; discharge curves; dimensions of pipe and specials; quantities required for joints; and other worthwhile dope. Sent on request.

Control of Rabies:

This excellent paper by Dr. G. A. Denison and Frank Hunter, Health Department, Birmingham, Ala., may not make engineers froth at the mouth with eagerness to get it; nevertheless it is worth a place in the library of every city, state and county official whose duties are such that he should be interested in community health. About the best on the subject we have seen. We believe a copy will be sent on request to Dr. Denison at the above address.

Mechanical Lifters:

In this small folder are shown more than 25 unusual mechanical lifters built specially for hard-to-handle equipment. You'll get some good ideas out of it if you have a lifting problem. Write George H. Corliss, Lewis-Shepard Co., Watertown, Mass., for a copy.

For the Mechanically Inclined:

A 56-page catalog and handy data book for mechanics. If you are not one of the 112,105 who have already received copies, write to Bonney Forge & Tool Works, Allentown, Pa., and they will send you a copy.

Protecting Steel Pipe:

A specification sheet on steel pipe protection has been prepared by Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis, Ind. A copy of this and other data will be sent on request to the above company.

Ten Diesels:

This is the story of the thousand-numbered Caterpillar diesels put out since October, 1931, when "old No. 1" went off the line. Nos. 1000, 2000, etc., were traced down. This book, which boasts all of Caterpillar's mastery of good illustrations, is full of real human interest. We have just one quarrel with them. To a veteran Timewaster, it seems as though, counting No. 1, there are 11 diesels and not ten. But it's a good book just the same. Write Caterpillar Tractor Co., Peoria, Ill., for a copy. No obligation.

Index to Advertisements

Activated Alum Corp..... 34
Allis-Chalmers Mfg. Co.....4 & 5
Alvord, Burdick & Howson..... 51
Armco Culvert M'f'rs. Assn.... 41
Austin-Western Road Machinery Co. 2

Barco Mfg. Co. 3
Barrett Co.....The Back Cover
Barstow & LeFeber..... 51
Black & Veatch..... 51
Browne, Floyd G. 51
Buffalo-Springfield Roller Co... 43
Burns & McDonnell Engr. Co... 51

Caird, James M..... 51
Calcium Chloride Assn..... 27
Cast Iron Pipe Research Assn. 47
C., H. & E. Mfg. Co. 38
Cleveland Tractor Co..... 59
Columbia Alkali Corp., The.... 27
Cramer & Sons, Robert..... 51

Dorr Company 37
Dow, A. W., Inc..... 51
Dow Chemical Co., The..... 27
Dresser Mfg. Co., S. R..... 32

Everett, Chester M..... 51
Everson Manufacturing Co..... 35

Friez & Sons, Inc., Julien P..... 34
Frink, Mfr., Carl H..... 43
Fuller & McClintock..... 51

Galion Iron Works & Mfg. Co... 8
Greeley & Hansen..... 51
Green Co., Howard R..... 51
Gruendler Crusher & Pulverizer Co. 43

Harrub Engineering Co..... 51
Hill, Nicholas S., Jr..... 51
Hitchings & Co..... 39
Hough Co., The Frank G..... 31

International Cement Corp.... 44
International Harvester Co..... 25

Jaeger Machine Co..... 31
Jensen, Bowen & Farrell..... 51

Koehring Co..... 41

Layne & Bowler, Inc..... 34
Link-Belt Co..... 50

M & H Valve & Fittings Co..... 35
Mall Tool Co..... 39
McWane Cast Iron Pipe Co..... 49
Metcalf & Eddy..... 52
Michigan Alkali Co..... 27
Morse Boulger Destructor Co... 39
Munsell Concrete Vibrators.... 38

Nichols Engineering & Research Corp..... 6

Pacific Flush Tank Co..... 39
Page Steel & Wire Div..... 43
Pirnie, Malcolm..... 52
Potter, Alexander..... 52

Quinn Wire & Iron Works..... 38

Roberts Filter Mfg. Co..... 35

Solvay Sales Corp..... 27
South Bend Foundry Co..... 38
Standard Oil Co. (Ind.).....28 & 29
Sterling Engine Co..... 32

Taylor, Henry W..... 52

West Steel Casting Co..... 31
Whitman & Howard..... 52
Wiedeman & Singleton..... 52
Wilson Engr. Co..... 52